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(Formerly Archives of Physical Therapy)

27th Annual Session

AMERICAN CONGRESS OF PHYSICAL MEDICINE

September 6, 7, 8, 9, 10, 1949

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VOLUME XXX JUNE, 1949 NO. 6

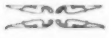
American Congress of Physical Medicine

27th Annual

Scientific and Clinical Session

Instruction Course

September 6, 7, 8, 9 and 10, 1949



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INSTRUCTION COURSE

In Conjunction with the

27th Annual Scientific and Clinical Session

AMERICAN CONGRESS OF PHYSICAL MEDICINE

September 6, 7, 8, 9, 1949

Netherland Plaza — **Cincinnati, Ohio**

TENTATIVE SCHEDULE

Physicians only may enroll for letter series

TUESDAY MORNING — SEPTEMBER 6		
(A) 10:00-10:50 A.M. Functional Anatomy of Shoulder and Arm Movie Demonstration Parlor H	(B) 11:00-11:50 A.M. Functional Anatomy of Hand Movie Demonstration Parlor H	
TUESDAY AFTERNOON — SEPTEMBER 6		
(C) 3:00-3:50 P.M. Therapeutic Exercise: Basic Principles Underlying Parlor H	(D) 4:00-4:50 P.M. Therapeutic Exercise: Neuromuscular Basis for Parlor H	
WEDNESDAY MORNING — SEPTEMBER 7		
(E) 8:30-9:20 A.M. Functional Anatomy of Hip and Thigh Movie Demonstration Parlor H	(F) 9:30-10:20 A.M. Functional Anatomy of Lower Leg and Knee Movie Demonstration Parlor H	
THURSDAY MORNING — SEPTEMBER 8		
(G) 8:30-9:20 A.M. Movement Patterns in Infants and Children Parlor H	(H) 9:30-10:20 A.M. Movement Patterns in Infants and Children Parlor H	
FRIDAY MORNING — SEPTEMBER 9		
(J) 8:30-9:20 A.M. Recent Developments in Physiology of Exercise Parlor H	(K) 9:30-10:20 A.M. Application of Electrical Principles to Vascular and Cardiovascular Problems Parlor H	

Physicians and registered physical therapy technicians may enroll for numbered series

TUESDAY MORNING — SEPTEMBER 6		
(1) 10:00-10:50 A.M. Braces: Anatomic Considerations in Prescribing and Fitting Parlor I	(2) 11:00-11:50 A.M. Special Braces to Favor Functional Activity Parlor I	
TUESDAY AFTERNOON — SEPTEMBER 6		
(3) 3:00-3:50 P.M. Electrodiagnosis: Clinical Uses and Interpretation of Golseth-Fizzell Apparatus Parlor I	(4) 4:00-4:50 P.M. Multiple Sclerosis: Evaluation and Prognosis for Physical Rehabilitation Parlor I	
WEDNESDAY MORNING — SEPTEMBER 7		
(5) 8:30-9:20 A.M. Muscular Imbalance: Evaluation and Treatment Parlor I	(6) 9:30-10:20 A.M. Research in Brace Making Parlor I	
THURSDAY MORNING — SEPTEMBER 8		
(7) 8:30-9:20 A.M. Cerebral Palsy (Spastic): Diagnosis and Prognosis Parlor I	(8) 9:30-10:20 A.M. Cerebral Palsy (Spastic) Patients: Muscle Reeducation Parlor I	
FRIDAY MORNING — SEPTEMBER 9		
(9) 8:30-9:20 A.M. Development of a Rehabilitation Center Parlor I	(10) 9:30-10:20 A.M. Muscle Strength Testing: Method, Interpretation and Importance in Evaluation for Rehabilitation Parlor I	

Note: The Committee on Education of the American Congress of Physical Medicine is in charge of the instruction course. It is purposely planned to limit the subjects in any year to a few topics, in order to devote enough time to those subjects to give those attending a good review, both from the standpoint of basic knowledge and from the clinical standpoint. Certain groups of these subjects will be repeated every three to five years.

Courses will be offered in two separate groups: One group of ten lectures will be offered on basic subjects and this group will be open only to physicians. A second group of ten lectures will present more general and clinical subjects. Physicians and physical therapy technicians may register for the second group of lectures. Only those physical therapy technicians who are registered with the American Registry of Physical Therapy Technicians will be permitted to enroll for instruction courses.

For full information and application form address

AMERICAN CONGRESS OF PHYSICAL MEDICINE

30 North Michigan Avenue — **Chicago 2, Illinois**

Contents—June 1949

Volume XXX No. 6

ARCHIVES OF PHYSICAL MEDICINE
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EDITOR OF THE MONTH

EARL C. ELKINS, M.D.

Rochester, Minnesota

Printed in U.S.A.

APPROVED SCHOOLS FOR PHYSICAL THERAPY TECHNICIANS *

Council on Medical Education and Hospitals of the American Medical Association

Name and Location of School	Medical Director and Technical Director	Entrance Requirements*	Duration of Course	Time of Admission	Maximum Enrolment	Tuition	Certificate, Diploma, Degree
Childrens Hospital, Los Angeles[1]	S. S. Mathews, M.D. Miss Sarah S. Rogers	a-b-d	14 mos.	Sept	14	$300	Cert. or Degree
College of Medical Evangelists, Los Angeles[1]	Fred B. Moor, M.D. R. William Berdan	a-b-c	15 mos.	Sept	16	$300	Cert. or Dipl.
University of Southern California, Los Angeles[1]	Charles L. Lowman, M.D. Miss Charlotte W. Anderson	c-d	14-24 mos.	FebSept	20	$569	Cert. or Degree
University of California Hospital, San Francisco[1]	Lucile M. Eising, M.D. Mrs. Margery L. Wagner	d	12 mos.	Sept	16	$220[2]	Cert. or Degree
Stanford University, Stanford University, Calif.[1]	W. H. Northway, M.D. Miss Lucille Daniels	a-b-d	12 mos.	Varies	18	$620	Cert. or Degree
University of Colorado Medical Center, Denver[1]	Harold Dinken, M.D. Miss Mary Lawrence	a-b-d	12 mos.	Sept	12	$300[3]	Cert. or Degree
Northwestern University Medical School, Chicago	John S. Coulter, M.D. Miss Gertrude Beard	a-b-d	12 mos.	Oct	16	$450	Certificate
State University of Iowa Medical School, Iowa City[1]	W. D. Paul, M.D.[5] Mrs. Olive Farr	e	12 mos.	Sept	15	$200	Certificate
University of Kansas School of Medicine, Kansas City[1]	Donald L. Rose, M.D. Mrs. Ruth G. Monteith	a-b-d	12 mos.	FebSept	15	$ 80[3]	Cert. or Degree
Bouve-Boston School of Physical Education, Boston	Howard Moore, M.D. Miss Constance Greene	H.S.	4 yrs.	Sept	15	$550	Dipl. & Degree
Simmons College, Boston	W. T. Green, M.D. Miss Janet B. Merrill	H.S.-e	1½-4½ yrs.	Sept	25	$550	Dipl. or Degree
Boston University College of Physical Education for Women, Sargent College, Cambridge, Mass.	Kenneth Christophe, M.D. Miss Adelaide McGarrett	H.S.-e-d	1-4 yrs.	Sept	30	$150	Cert. or Degree
University of Minnesota, Minneapolis[1]	M. E. Knapp, M.D. Miss Ruby M. Green	H.S.	4 yrs.	Sept	16	$580[2]	Degree
Mayo Clinic, Rochester, Minn.[1]	Earl C. Elkins, M.D. Miss Helen Belknap	a-e	12 mos.	Sept	30	None	Certificate
Barnes Hospital, St. Louis[1]	Sedgwick Mead, M.D. Miss Beatrice Schulz	c	2 yrs.	Sept	12	$400	Degree
St. Louis University School of Nursing, St. Louis[1]	A. J. Kotkis, M.D. Sister Mary Imelda	H.S.	4 yrs.	JanSept	10	$300	Degree
Albany Hospital, Albany, N. Y.	I. W. Ghormley, M.D. Miss Catherine Graham	a-b-d	12 mos.	Sept	6	$250	Certificate
Columbia University College of Physicians and Surgeons, New York City[1]	William B. Snow, M.D. Miss Floy Pinkerton	a-c-e	1-2 yrs.	Sept	50	$710	Cert. or Degree
New York University School of Education, New York City[1]	George G. Deaver, M.D. Miss Elizabeth Addoms	a[2]-b-d	12 mos.	Sept	40	$600	Cert. & Degree
Duke Hospital, Durham, N. C.[1]	Lenox D. Baker, M.D. Miss Helen Kaiser	a-b-d	15 mos.	Oct	12	$300	Certificate
D. T. Watson School of Physiatrics, Leetsdale, Pa.[1]	Jessie Wright, M.D. Miss Kathryn Kelley	a-b-d	12 mos.	Oct	30	$300	Diploma
Graduate Hospital of the University of Pennsylvania, Philadelphia[1]	George M. Piersol, M.D. Miss Dorothy Baethke	a-b-d	12 mos.	Sept	20	$400	Certificate
University of Texas School of Medicine, Galveston[1]	G. W. N. Eggers, M.D. Miss Ruby Decker	b-d	12 mos.	Jan	8	$163[2]	Certificate
Hermann Hospital, Houston[1]	Oscar O. Selke, Jr., M.D. Mary Elizabeth Kolb	a-b-d	12 mos.	Oct	12	$300	Cert. or Degree
Baruch Center of Physical Medicine of the Medical College of Virginia, in affiliation with Richmond Professional Institute, Richmond[1]	Walter J. Lee, M.D. Miss Susanne Hirt	H.S.-a-b-c-d-e	1-4 yrs.	Sept	54	$275[2]	Dipl. or Degree
University of Wisconsin Medical School, Madison	Harry Bouman, M.D. Miss Margaret A. Kohli	a-b-c H.S.	12 mos. 4 yrs.	FebSept Sept	20 20	$120[2] $120[2]	Certificate Cert. & Degree

* Courses are so arranged that any of the entrance requirements will qualify students for training. a = Graduation from accredited school of nursing; b = Graduation from accredited school of physical education; c = Two years of college with science courses; d = Three years of college with science courses; e = Four years of college with science courses. H.S. = High school graduation.

1. Male students are admitted.
2. R.N. plus one year college.
3. Nonresidents charged additional fee.

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APPROVED SCHOOLS FOR OCCUPATIONAL THERAPY TECHNICIANS *

Council on Medical Education and Hospitals of the American Medical Association

NOTE: The duration of the course is expressed in academic years

Name and Location of School	College Affiliation	Duration of Course	Classes Start	Entrance Requirements	Tuition Per Year	Certificate, Diploma,	Graduates in 1947
University of Southern California, 923½ 35th Place, Los Angeles	University of Southern California	2 yrs. 5 yrs.	FebSept FebSept	Degree High sch.	$420 $450	Certificate Cert.&B.S.	22
Mills College, Oakland, Calif.	Mills College	3 yrs.	FebSept	Degree	$200 $550	Certificate	....
San Jose State College, San Jose, Calif.	San Jose State College	1½ yrs. 3¼ yrs.	Varies Varies	Degree High sch.	$ 21 $ 21	Certificate Degree	10
University of Illinois College of Medicine, 1853 W. Polk St., Chicago	University of Illinois	5 yrs.	Feb	High sch.	$152	B.S.	14
University of Iowa, Iowa City, Iowa	State University of Iowa, College of Medicine	5 yrs.	.....	High sch.	$ 85	Cert.&Deg	
University of Kansas, Lawrence	University of Kansas	2 yrs. 4 yrs.	FebSept FebSept	Degree High sch.	$131 $131	Certificate B.S.	10
Boston School of Occupational Therapy, 7 Harcourt St., Boston	Tufts College	2 yrs. 5 yrs.	Sept Sept	Degree High sch.	$500 $450	Diploma B.S.	13
Wayne University, 4841 Cass, Detroit, Mich.	Wayne University, College of Med., Coll. of Liberal Arts, Coll. of Education	5 yrs.	.....	High sch.	.....	.....	
Kalamazoo School of Occupational Therapy, Western Michigan College of Education, Kalamazoo	Western Michigan College of Education	1½ yrs. 4 yrs.	FebSept FebSept	Degree 1 yr. coll.	$127 $127	Diploma Degree	20
Michigan State Normal College, Ypsilanti	University of Michigan	5 yrs.	Varies	High sch.	$118	Cert.&Deg.	8
University of Minnesota, Church Street, Minneapolis	University of Minnesota	4 yrs.	.....	High sch.	$360	B.S.	
College of St. Catherine, St. Paul, Minn.	The College of St. Catherine	3½ yrs.	Varies	1 yr. coll.	$210	Degree	4
Washington University School of Medicine, St. Louis	Washington University	3 yrs.	Sept	2 yrs. coll.	$400	Degree	10
University of New Hampshire, Durham	Univ. of New Hampshire	5 yrs.	Sept	High sch.	$160	Cert.&Deg.	6
Columbia University College of Physicians and Surgeons, 630 W. 168th St., New York City	Columbia University	1½ yrs. 2½ yrs.	Sept Sept	Degree 2 yrs. coll.	$450 $450	Certificate Degree	28
New York University School of Education, 100 Washington Sq. E., New York City	New York University	4½ yrs.	FebSept	High sch.	$500	Cert.&Deg.	20
Ohio State University, Columbus	Ohio State University	3 yrs.	Quarterly	High sch.	$105	Degree	21
Philadelphia School of Occupational Therapy, 419 S. 19th St., Philadelphia	University of Pennsylvania	1½ yrs. 3 yrs.	Sept Sept	Degree 1 yr. coll. High sch.	$500 $500 $600	Diploma Diploma	35
Texas State College for Women, Denton, Tex.	Texas State College for Women	5 yrs.	FebSept	High sch.	$150	Degree	13
Richmond Professional Institute, 901 W. Franklin St., Richmond, Va.	Medical College of Virginia	1½ yrs. 3 yrs.	Sept Sept	Degree 1 yr. coll.	$200 $200	Certificate Certificate	20
College of Puget Sound, Tacoma, Wash.	College of Puget Sound	3 yrs. 5 yrs.	FebSept FebSept	Degree High sch.	$350 $300	Certificate Cert.&Deg.	
University of Wisconsin, Madison	University of Wisconsin	4 yrs.	FebSept	High sch.	$320	Cert.&Deg.	8
Milwaukee-Downer College, Dept. of Occupational Therapy, 2512 E. Hartford, Milwaukee	Milwaukee-Downer College	2½ yrs. 4 yrs.	Sept Sept	1 yr. coll. High sch.	$300 $300	Diploma Dipl.&Deg.	22
Mount Mary College, 2900 Menomonee River Dr., Milwaukee		Varies	Sept	Degree	$335	Certificate	15
University of Toronto, Dept. of University Extension, Toronto, Ont., Canada	University of Toronto	5 yrs. 3 yrs.	Sept Sept	High sch. 1 yr. coll.	$260 $222	B.S.Deg. Diploma	110
Colorado Agricultural and Mechanical College, Fort Collins, Colorado		5 yrs.	Sept	High sch.	.....	B.S.	

* Rep. in part J. A. M. A. 137:1460 (Aug.) 1948.

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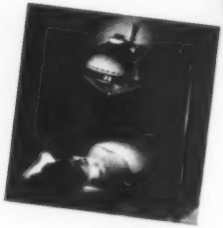

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PROGRESSIVE RESISTANCE EXERCISES IN CUP ARTHROPLASTIES OF THE HIP *

THOMAS L. DE LORME, M.D.
Baruch Fellow in Physical Medicine, Harvard Medical School and Massachusetts General Hospital

and

ARTHUR L. WATKINS, M.D.
Associate in Medicine, Harvard Medical School;
Chief of Physical Medicine, Massachusetts General Hospital

BOSTON

Many problems are encountered in the postoperative treatment of patients with vitallium cup arthroplasty of the hip. Their solution depends in great measure on the close cooperation of the surgeon and the physiatrist. Sufficiently different sets of mechanical and functional problems are encountered to necessitate considerable variations from the routine outlined for the average case. Along with the surgeon, the physiatrist must plan an effective and flexible exercise program to obtain maximum painless function.

The rehabilitation of the cup arthroplasty patient may be divided into three phases: (1) the first four postoperative weeks; (2) the ambulatory hospital period, which starts when the patient first becomes ambulatory and extends until he is discharged (for most patients this is the eighth week); (3) the convalescent or final phase, which starts at the end of the eighth week and continues until maximum function has been obtained.

Immediate Postoperative Phase

Immediately after operation the operated extremity is placed in balanced suspension traction with 5 pounds of weight. The leg is placed in maximum abduction and internal rotation. Usually on the third or fourth day, while still in traction, muscle-setting exercises are begun. The following muscles participate: (1) knee extensors; (2) hip rotators; (3) hip abductors, and (4) hip extensors. The patient is also instructed in ankle and toe exercises. These exercises are performed once or twice each waking hour. Between the third and fifth week traction is usually removed and additional exercises are added.

Ambulatory Hospital Phase

After the first month, the patient's activities are considerably increased. Active nonresistive hip exercises are continued, and, in addition, a stationary bicycle is used for ten minutes twice daily and sometimes roller skating exercises in bed for abduction. Ambulation is initiated in a walker and graduated to crutches with minimal weight bearing, and later stair climbing. Occasionally during this period the patient may, because of joint pain or adductor muscle spasm, have difficulty in performing the hip exercises prescribed. This difficulty is frequently overcome by having him perform the exercises initially in the Hubbard tank. These underwater exercises are done three to five times weekly and usually may be stopped in two to three weeks. The average patient is discharged from the hospital eight weeks postoperatively, to carry on the same routine at home.

* Aided by a grant from the Pope Foundation, Inc.
* Read at the Twenty-Sixth Annual Session of the American Congress of Physical Medicine, Washington, D. C., Sept. 9, 1948.

Convalescent Phase

The patient now encounters more complex functional problems. He is allowed to bear more and more weight, refines his gait, graduating from crutches to cane and later to no appliances at all, and if necessary, redevelops inadequate musculature and attempts to increase joint motion. His crutch gait is checked at regular intervals and between the sixth and ninth month a patient with unilateral arthroplasty is permitted to bear full weight and to start the use of the cane in the opposite hand. A patient with bilateral operations remains on crutches for approximately one year and is then brought to full weight bearing rapidly. One or even two canes may be used during

Fig. 1. — Pulley arrangement used for exercising hip rotators. By moving the pulley to the other table leg, the rotators of the opposite hip may be exercised.

this transition period. If at the end of the third month the hip muscles have not recovered adequate strength, progressive resistance exercises are started. Jumping exercises (in place, side to side, and front to back) may also be employed for increasing coordination and strength. Eventually when the patient is allowed to discard all appliances and bear full weight, intensive gait training is started and continued until he obtains the best possible gait for the existing hip mechanics.

Technic of Progressive Resistance Exercises

It is the main purpose of this paper to discuss the technic employed for redeveloping muscle power in these patients as well as to summarize briefly the response of 21 of these patients to progressive resistance exercises. The patients selected for resistance exercises were those whose symptoms were

thought to be due to inadequate muscular support about the hip. Resistance exercises are most commonly employed at the end of the third month; however, for some patients they have been started as late as ten years after operation. The present tendency is to employ the exercise equipment as early as the end of the fifth week, as it allows active exercise with minimal resistance by counterbalancing. The aim at this time is chiefly to maintain motion and encourage formation of new joint cartilage rather than to strengthen musculature.

Hip Rotation. — The arrangement shown in figure 1 is for external rotation of the hips. The sitting position allows exercise in the presence of a flexion contracture. A similar arrangement is used for exercising the internal rotators with the pull in the opposite direction.

Hip Abduction. — Hip abduction may be performed in several positions, the best one for the individual patient being selected. If the patient does not substitute too greatly with the lateral abdominal muscles, the arrangement shown in figures 2 and 3 may be employed. This also accomplishes stretching of the adductors if they are contracted and for counterbalancing extremely weak hip abductors or for resisting the adductors. If there have

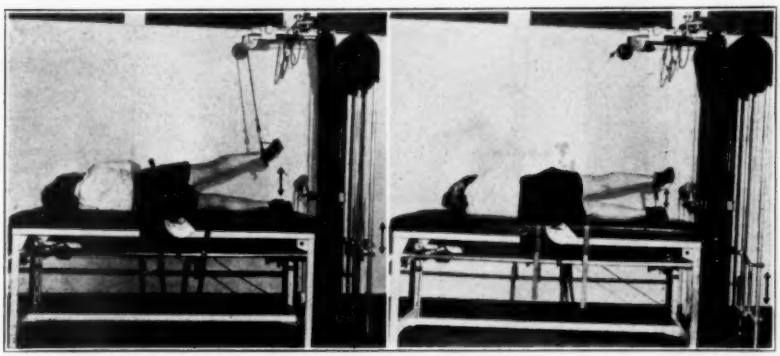

Fig. 2 (left). — Load assisting hip abduction.
Fig. 3 (right). — Load resisting hip abduction.

been bilateral arthroplasties, the two hips may be exercised simultaneously, as shown in figure 4. In case of a unilateral arthroplasty the hip may also be exercised in the same fashion, as shown in figure 5, the leg not exercising being swung over the table edge and strapped to fix the pelvis. If there is an extremely weak abductor or limited hip abduction, the muscles may be exercised from a position of maximum length, as shown in figure 6. In this instance gravity assists the muscle contraction.

Hip Flexion. — Hip flexor exercises are numerous, and usually a satisfactory arrangement to meet the individual problem is readily obtained. Figure 7 illustrates hip flexion by counterbalanced straight leg raising, while in figure 8 the load resists flexion. To prohibit participation of the rectus femoris and reduce pelvic flexion, hip flexion may be given while the patient is prone, lying with knee flexed (fig. 9). As gravity assists, weak as well as strong muscles may be exercised in this position. This also permits the muscle to be worked from a position of maximum length. With limited hip extension the pelvis is elevated, as in figure 10.

Hip Extension. — Hip extension exercises directed toward development of the gluteus maximus are usually more difficult to perform. The position shown in figure 7 is useful but does not call for strenuous gluteus maximus action. Figure 11, however, illustrates an exercise which calls for maximum exertion of the gluteus maximus. The performance of this exercise is dependent, however, on good erector spinae power and the patient's ability to learn to exercise the weak gluteus maximus with the normal one. If there have been bilateral arthroplasties with resultant equal hip extension range, this arrangement is excellent. If there is concurrent quadriceps fe-

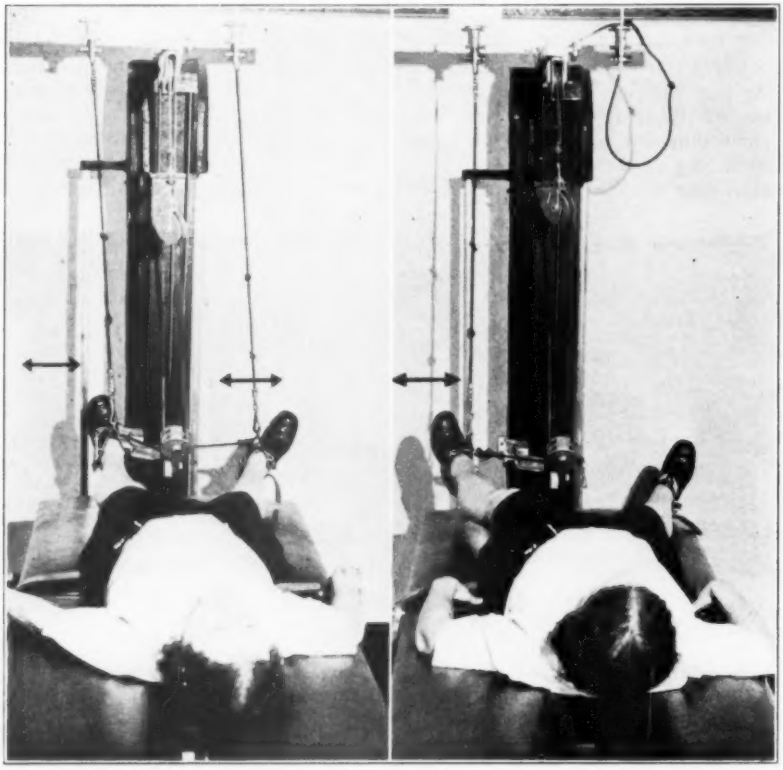

Fig. 4 (left). — Method of exercising abductors of the two hips simultaneously.
Fig. 5 (right). — Unilateral hip abductor exercise. The opposite leg may be strapped over the edge of the table (as shown) or simply to the table top if there is limited abduction.

moris weakness, the exercise shown in figure 12 may be employed, giving combined resistance to hip and knee extension.

Patients who are obese have poor abdominal as well as poor hip flexor strength and are given the combined abdominal and hip flexor exercise as in figure 13.

Exercise Routine. — Not all the exercises shown are employed in each case. Individual analysis reveals the joint ranges and muscle powers that should be increased. The optimum exercise positions are then determined. Most patients exercise once daily and four days weekly. Each exercise is per-

formed for 30 repetitions. These are divided into three sets of exercise with 10 repetitions per set.

Load-resisting exercises are needed for muscles of sufficient strength initially to lift the extremity against gravity. The resistance for the first set of 10 repetitions is approximately 50 per cent of the 10 repetition maximum; for the second set, approximately 75 per cent of the 10 repetition maximum, and for the last set, the 10 repetition maximum.

Weaker muscles are exercised in two ways: (1) with gravity-assisting and (2) with load-assisting exercises. If gravity-assisting exercises are employed, the poundages (resistances) per set are determined as previously outlined for load-resisting exercises. However, if load-assisting exercises are used, then the exercise load is based on the 10 repetition minimum (least amount of help needed to perform 10 repetitions). In this case the approximate poundages employed for each set of exercises are: first set, 2 times the repetition minimum; second set, 1½ times the repetition minimum; third set, 10 repetition minimum.

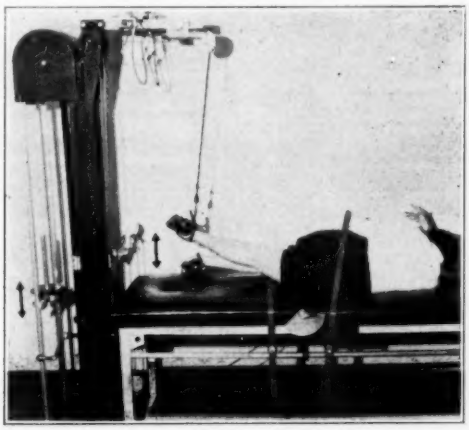

Fig. 6. — Gravity-assisting hip abduction.

Each week the new 10 repetition maximum or minimum is obtained, and from these the resistances to be used for the ensuing week are determined. It is best to start exercise under supervision of a therapist, and it should usually be continued for a minimum of eight weeks. Frequently it is beneficial to continue six months to a year.

Results

Twenty-one patients representing 29 cup arthroplasties (8 bilateral) were given progressive resistance exercises. This type of exercise was recommended as it was felt that the limp or pain for which the patients were referred for treatment was most probably due to muscular weakness. The interval between operation and the exercise program varied from two months to ten years. Four observations of response to exercise were made. They were of (1) pain, (2) gait, (3) hip flexor strength and (4) abductor strength.

Twelve of the 29 hips were painful initially. Eight of these had marked reduction or complete alleviation of pain on exercise. The remaining 4 showed no improvement.

Only 1 of the 21 patients walked without a significant limp. The remainder manifested varying degrees of a combination gluteus medius and short leg limp. Eleven showed an improvement in gait due to improvement of gluteus medius power. Nine showed no improvement.

Because of the common complaint of pain, lack of accurate measuring devices and unreliability of single effort muscle tests for measuring true potential muscle power, the hip flexor and abductor power was evaluated simply on the basis of whether or not these muscles could lift the lower extremity (knee extended) against gravity.

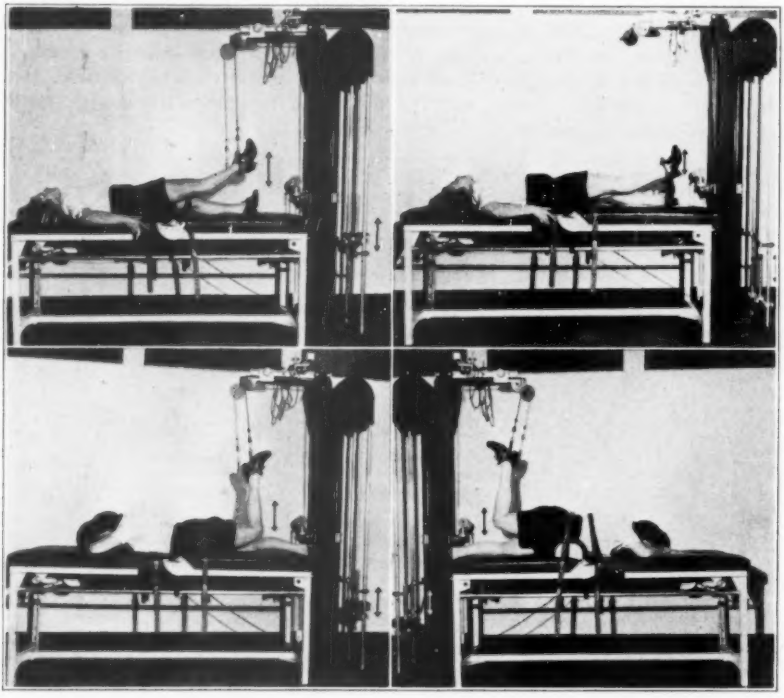

Fig. 7 (top left). — Load-assisting straight leg raising. This arrangement may also be used for load-resisting hip extension.

Fig. 8 (top right). — Load-resisting straight leg raising.

Fig. 9 (bottom left). — Hip flexor exercise in which rectus femoris action is prevented and influence of abdominal muscles reduced.

Fig. 10 (bottom right). — Same exercise, except that elevation is placed under the pelvis to allow for flexion contracture.

Twenty-five of the 29 hips could not abduct against gravity initially. Eighteen of these regained this function. Nineteen of the 29 could not perform straight leg raising against gravity initially. Fifteen of these gained this function; 4 did not. The chief reasons for most patients' inability to increase muscle strength were: (1) persistent pain, (2) difficulty in breaking long-standing habit patterns, (3) poor individual cooperation and (4) inadequate period of exercise. Of these, pain and inability to break faulty habit patterns were probably most responsible. The latter difficulty em-

phasizes the desirability of supervision at an early postoperative date to teach optimum use of hip mechanics.

Muscular development should be continued until maximum subjective and objective improvement has been obtained. If, however, pain is relieved or the gait improved before maximum power has been developed, the exercises should be continued to obtain maximum strength.

Although the exercises were not designed for strenuous contractions through the extreme limits of joint motion, there were frequent reports of new activities made possible because of an increased range of motion, usually hip flexion. For example, three patients regained ability to tie their shoes and cut their toenails; another could step on and off busses again, while still another could lift the foot from the brake to the accelerator. All these gains, of course, were due to an increase in hip flexion.

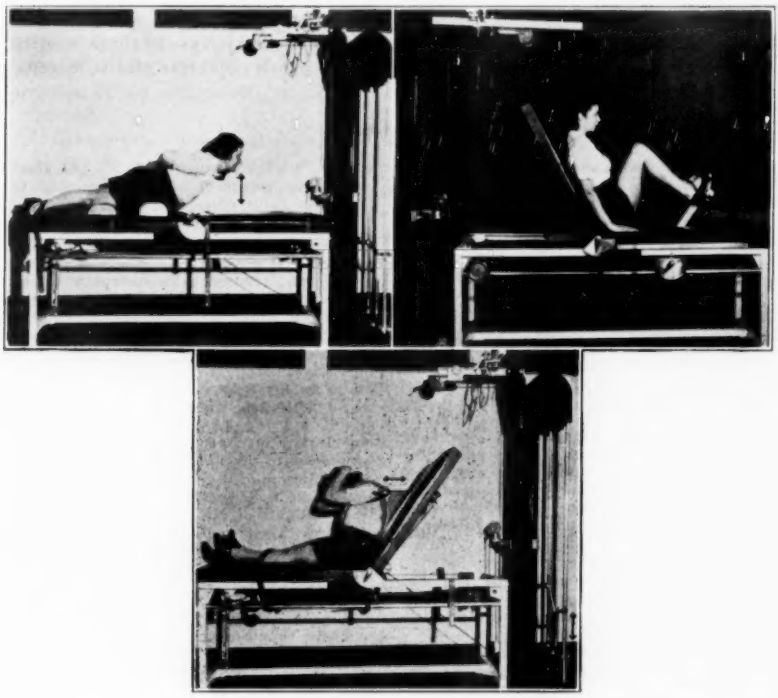

Fig. 11 (left). — Hip extensor exercise (see text for explanation).
Fig. 12 (right). — Combined knee and hip extension exercise. From the position shown here the hips and knees are extended against resistance.
Fig. 13 (bottom). — Abdominal and hip flexor exercise.

Summary

The rehabilitation of the cup arthroplasty patient is divided into three phases: (1) the immediate postoperative, which includes the first four weeks; (2) the ambulatory hospital period, which starts when the patient first becomes ambulatory and extends until he is discharged (for most patients this is the eighth week); (3) the convalescent or final phase, which starts at the

end of the eighth week and continues until maximum function has been obtained. The important physical therapy measures employed in each phase have been discussed.

Several methods for exercising each hip muscle have been presented. With proper individual case analysis and therapeutic exercise equipment, optimum exercise routines for restoring joint motion and muscle power are possible even in the most complicated mechanical situations.

Progressive resistance exercises are useful in restoring hip muscle strength in these patients; they are usually started at the end of the third month but may start earlier with minimal resistance and counterbalancing.

Progressive resistance exercises are advocated four days weekly, once daily. Each exercise is carried through 30 repetitions, which are broken up into three sets of 10 repetitions each. Ten Repetition Maximums and Minimums are determined weekly for measurement of progress.

Except where hindered by pain, lack of cooperation or firmly rooted habit patterns, muscle strength substantially improved in one to three months of exercise. The increased strength resulted in both objective and subjective functional improvement.

Discussion

Dr. Carl L. Levenson (Chester, Pa.): I was one of those fortunate enough by circumstances to watch the development of the DeLorme exercise program from its inception at Gardner General Hospital and subsequently to see its adaptation to various disabilities in institutions throughout the country. I remember the enthusiasm about five years ago at Gardner General Hospital, when DeLorme first showed us the application of his heavy weight-lifting exercises to knee disabilities. I remember the flow of ideas which the original demonstrations stimulated. Subsequently I saw how some of these ideas became practical realities, how they were applied in chest injuries at Fitzsummons General Hospital and how they were applied to fractured backs. Here is another extension of the ideas to the rehabilitation of those who have been subjected to cup arthroplasties in Boston.

The authors of this paper are to be congratulated for their thoroughness and the critical analysis of their clinical material before prescription of the exercises and the analysis of their results.

We all know how disabling are the mechanical defects of those who require cup arthroplasty. At the very beginning, in their introduction, the authors made a very important simple statement; that much of their results depended upon the cooperation between the orthopedic surgeon and the physiatrist. I should like to emphasize that.

I wonder whether some of the results, particularly where there have been persistently bad locomotion habit patterns as the result of prolonged mechanical hip difficulty, might not have been better had the physiatrist been given opportunity of seeing the patient preoperatively and starting earlier treatment to overcome bad locomotion habit patterns before surgery.

I saw such a program in thoracoplasties and was deeply impressed by the effectiveness of the exercise program when the patient was trained before surgery. After all, locomotion involves almost every muscle of the body. Posture and locomotion are not merely the action of certain groups of muscles in the involved extremity, but the associated movements of other limbs and muscle groups are also important. Although these associated movements and the coordination of numerous muscle groups in walking are automatic later in life, they require some two years of training in childhood to be established. When we have years of poor habit patterns behind us, it takes a long time to overcome these patterns.

It seems to me that early preoperative training, particularly for posture and for the associated movements in walking, might add something to this program.

Again, I think the authors are to be commended for this adaptation of DeLorme's exercise program to cup arthroplasties.

Dr. Watkins (closing): I should like to thank Dr. Levenson for pointing out that important factor of starting early preoperative and postoperative therapeutic exercise and training in proper walking.

The patients in whom we did not get good results were those who had had no such training for periods of four to five years, and even though we could increase muscle power, we found it very difficult to overcome bad habits of gait.

POTASSIUM IN DENERVATED, TREATED AND NONTREATED MUSCLE *

ERNST FISCHER, M.D.

RICHMOND, VA.

In all modern theories of the fundamental mechanism by which excitation releases energy, which is transformed during muscular contraction into useful mechanical work, some important key position is held by the potassium ions.[1] Although quite different roles are assigned to potassium in these various theories, they all have in common the principle that any substantial change in potassium concentration inside the muscle fibers affects their contractile power. Besides this direct involvement in the contractile mechanism, potassium appears to serve the useful purpose of keeping myosin, the main protein of the muscle, in its proper colloidal state, so that folding of the myosin chain molecules can occur, which then causes the shortening of the muscle.[2]

In previous investigations,[3] it was demonstrated that during denervation atrophy "extractable myosin" diminishes considerably and that this myosin loss can be retarded, but not prevented completely, by daily appropriate electrical treatment. The experiments reported in this paper were performed as an attempt to correlate, if possible, the changes in myosin with changes in potassium. All experiments were carried out on the gastrocnemius muscles of rabbits. Potassium, and in the more recent experiments also sodium, was determined after dry-ashing of the samples by a flame photometer with lithium as an internal standard.[4] All elecrolyte concentrations were expressed as milliequivalent per 100 Gm. wet weight.

To correlate the observed loss in potassium with the time elapsed since denervation or with the weight loss was rather difficult, since the potassium concentration, even for normal muscles, varied very much from one animal to another. This large variability of the potassium concentration, the probable causes of which will be discussed later, is apparently responsible for some of the contradictory statements concerning the changes in potassium concentration brought about by denervation.[5] The large number of our data permits statistical evaluation, which reveals that the changes, as shown by the graphic representation in chart 1, are significant. After an initial transient potassium gain, which had already been observed by Fenn,[5c] potassium is lost at a considerable rate with progressing denervation atrophy.

The potassium loss found for the rabbit muscles is much larger than that reported by Hines and Knowlton[5b] for rat gastrocnemius muscles. In their experiments, the decrease in potassium per gram of muscle weight

* From the Basic Research Division, Baruch Center of Physical Medicine, Medical College of Virginia. This work was done under contract between the Office of Naval Research and the Medical College of Virginia. The investigations were performed in collaboration with Dr. George H. L. Dillard and Miss N. J. Copenhaver.

* Read at the Twenty-Sixth Annual Session of the American Congress of Physical Medicine, Washington, D. C., Sept. 10, 1948.

1. Ernst, E.: Klin. Wchnschr. **15**:1641, 1936. Reginster, A.: Arch. internat. de physiol. **47**:71, 1938. Ernst, E., and Mórocz, E.: Enzymologia **9**:127, 1940. Verzár, F.: Theorie der Muskelkrontraktion, Basel, Benno Schwabe, 1943. Erdős, T.: Hung. acta physiol. et biol. **1**:32, 1946. Szent-Györgyi, A.: Chemistry of Muscular Contraction, New York, Acad. Press, 1947.

2. Fenn, W. O.: Contractility, in Hoeber, R.: Physical Chemistry of Cells and Tissues, Philadelphia, The Blakiston Company, 1945.

3. (*a*) Fischer, E.: Am. J. Physiol. **145**:571 and 583, 1946; (*b*) Arch. Phys. Med. **29**:291, 1948.

4. Berry, J. W.; Chappell, D. G., and Barnes, R. B.: Indust. & Engineering Chem. Analyt. Ed. **18**:19, 1946.

5. (*a*) Leulier, A.; Bernard, A., and Richard, A.: Compt. rend. Soc. de biol. **110**:848, 1932. (*b*) Hines, H. M., and Knowlton, G. C.: Am. J. Physiol. **104**:379, 1933 and **120**:719, 1937. (*c*) Fenn, W. O.: ibid. **120**:675, 1937. (*d*) Fenn, W. O.; Cobb, D. M.; Manery, J. F., and Bloor, W. R.: ibid. **121**:595, 1938.

could be explained as only an apparent decrease in potassium concentration caused by the relative increase of the "connective tissue space," which is practically free of potassium.[6] The calculated potassium content of the "true muscle space" remained constant. Hines and Knowlton assumed for their calculations the generally accepted value of 15 per cent for the "connective

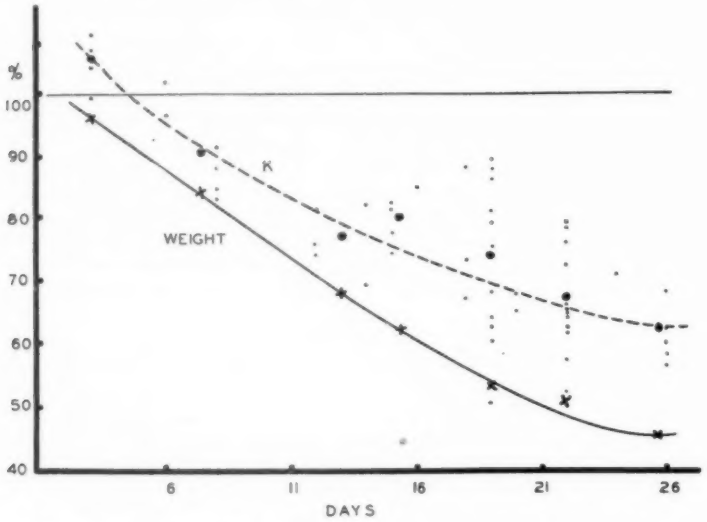

Chart 1. — Weight and potassium changes in denervated muscles expressed in per cent of corresponding values of the normal control muscles. Small dots, individual potassium values; large dots and crosses, mean potassium values and mean weights for muscles grouped according to duration of denervation.

tissue space" of normal muscle.[7] Chart 2 demonstrates that for our data a constancy of the potassium concentration for the muscle space proper can be calculated only if an initial connective tissue space of 28.5 per cent is assumed, which is much too high a value. Even then, the calculated values correspond more or less closely with the observed potassium content only for the period from the sixth to the sixteenth day. Of the various muscle constituents which we have investigated during the last years,[3] only myogen (zymohexase) follows a course during denervation atrophy which would indicate maintenance of a constant concentration for the muscle space during an initial period of eleven days. From our potassium data, it is obvious that the potassium loss, which becomes distinct from the fifth to the sixth day after denervation, is a progressive loss from the muscle space proper. In this later stage of atrophy, the ratio between potassium concentration and relative weight of the muscles remains more or less constant. Similarly, in this stage of atrophy, the ratio between potassium concentration and extractable myosin alters little.

However, these ratios are constant only if calculated from mean values. Even for normal muscles, the individual determinations, for both myosin and potassium, vary very much from one animal to another. Since often a high potassium concentration is found when only little myosin can be extracted, and vice versa, the mean ratio between potassium concentration and myosin

6. Fenn, W. O.: Physiol. Rev. **16**:450, 1936.
7. Knowlton, G. C., and Hines, H. M.: Proc. Soc. Exper. Biol. & Med. **35**:394, 1936.

for normal muscle, calculated in arbitrary units, has a standard deviation of ±22 per cent. The mean potassium concentration for normal muscle is 9.06 ±0.21 mEq. per 100 Gm. of muscle and had a standard deviation of ±1.03, which corresponds to only about ±12 per cent.

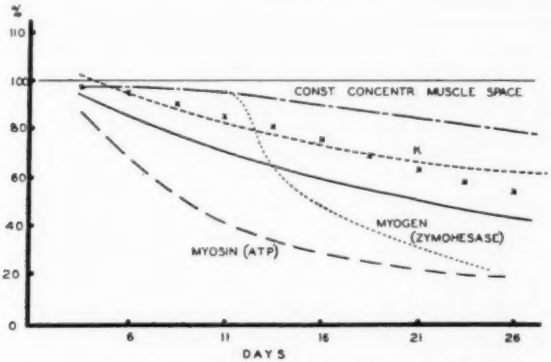

Chart 2. — Comparison of changes in weight, potassium, myogen (zymohexase) and myosin (adenosine triphosphatase) during denervation atrophy. Theoretical curve for apparent change of a muscle constituent due only to the relative increase of the connective tissue (initially 15 per cent) but without any concentration change in the true muscle space. Crosses, theoretical values of potassium under the assumption that potassium remains constant in the muscle space and that the initial connective tissue space is 28.5 per cent.

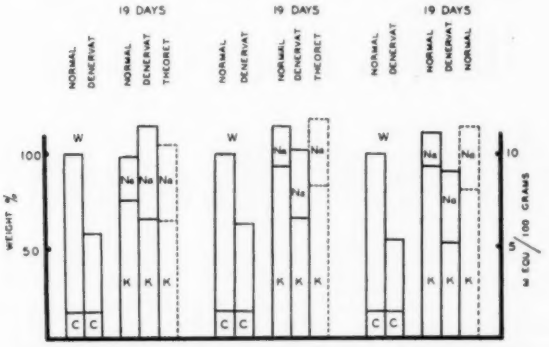

Chart 3. — Weight, potassium and sodium values for normal and experimental muscles denervated for nineteen days. Last vertical bar for each experiment represents theoretical electrolyte distribution, under the assumption that all changes are due only to the relative increase in connective tissue (initially 15 per cent).

The large variability of the potassium content of normal muscle is probably due to the well known influence of age,[8] of the endocrine balance[9] and of the diet[10] on muscle potassium. Fenn[11] emphasized that shifts in the glycogen storage of the muscle affects its potassium content. In consequence, all the various factors changing the glycogen content of the muscle[12] will also alter indirectly the potassium content.

8. Leulier, A., and Bernard, A.: Bull. Soc. chim. biol. **16**:1663, 1939.
9. Hoagland, H., and Stone, D.: Am. J. Physiol. **152**:422, 1948.
10. Conway, E. J., and Hingerty, D.: Biochem. J. **42**:372, 1948. Darrow, D. C.; Schwarts, R.; Iannucci, J. F., and Colville, F.: J. Clin. Investigation **27**:198, 1948.
11. Fenn, W. O.: Physiol. Rev. **20**:377, 1940.
12. Soskin, S., and Levine, R.: Carbohydrate Metabolism, Chicago, University of Chicago Press, 1946.

Probably, the same factors which influence the initial potassium concentration also condition the rate of potassium loss during denervation atrophy. Muscles with comparable atrophy (chart 3) might show a potassium loss of nearly 50 per cent or a loss so small that it can be explained completely by the relative increase of the connective tissue. Although statistically the potassium loss increases with the duration of denervation, the rate of the

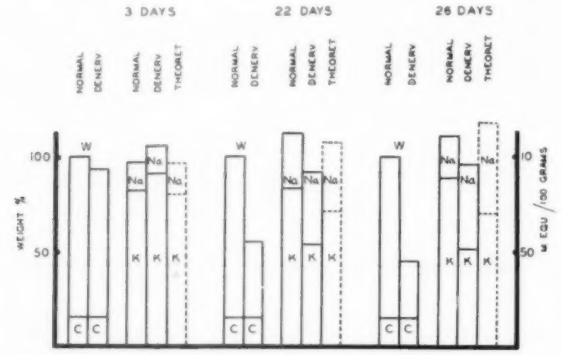

Chart 4. — Weight, potassium and sodium values for normal and experimental muscles, three, twenty-two and twenty-six days, respectively, after denervation. Last vertical bar for each experiment represents the theoretical electrolyte distribution under the assumption that all changes are due only to the relative increase in connective tissue (initially 15 per cent).

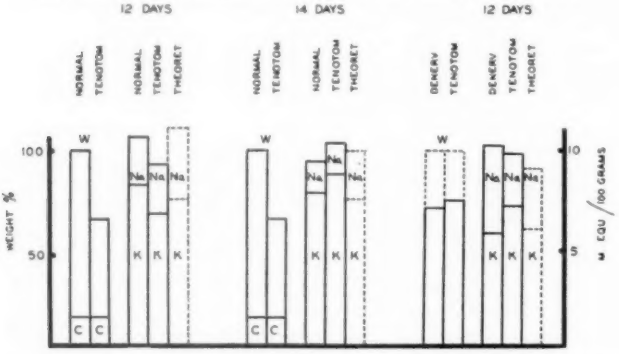

Chart 5. —Weight, potassium and sodium values for normal and experimental muscles twelve and fourteen days after tenotomy. In the last experiment values were determined on one muscle twelve days after denervation and on another twelve days after tenotomy. The upper part of the weight bars for the last experiment indicate the probable original weight of the muscles before operation. The last vertical bar for each experiment represents the theoretical electrolyte distribution under the assumption that all changes are due only to the relative increase in connective tissue (initially 15 per cent.)

potassium loss increases with the duration of denervation, the rate of the potassium loss for an individual muscle depends apparently, to a large extent, upon its initial potassium concentration. As a rule, relatively small losses are observed if the initial potassium value was already rather low. Similar variability and dependence of the extent of changes in the potassium concentration upon initial potassium values have been observed recently by others, in studies of the effect of altered plasma potassium on muscle potassium.[10]

While the potassium decreases during denervation atrophy, the sodium content increases more or less in correspondence (charts 3 and 4). This increase in sodium content is nearly always larger than can be explained by the relative increase in connective tissue space. Apparently, during denervation atrophy, sodium replaces potassium in the muscle space, at least to a certain extent. Similarly, more or less partial replacement of potassium by sodium has been demonstrated after feeding of diets low or high in potassium,[10] during muscular activity[13] and during soaking of isolated muscles in electrolyte solutions.[14]

The large loss of potassium and its partial replacement by sodium are typical for denervation atrophy. In atrophy due to tenotomy, the potassium loss also varies a good deal but less than in denervation atrophy. The mean loss is rather small, since often small increases in potassium also occur. In tenotomy atrophy, only occasionally was an observed potassium loss larger

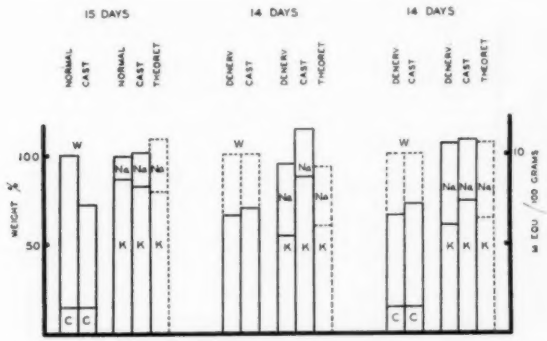

Chart 6. — Weight, potassium and sodium values for normal and experimental muscles immobilized by cast fifteen days. In the second and third experiments values were determined on one immobilized for fourteen days and on the other fourteen days after denervation. The upper parts of the weight bars for the last two experiments indicate the probable weight of the muscles before operation. The last vertical bar for each experiment represents the theoretical electrolyte distribution under the assumption that all changes are due only to the relative increase in connective tissue (initially 15 per cent).

than the change which could be explained by the relative increase in connective tissue space (chart 5). The sodium increase, if present at all, was always smaller than theoretically expected.

In true disuse atrophy brought about by application of a cast, there was even less tendency for a potassium loss than in tenotomy atrophy (chart 6). The difference between potassium changes during denervation atrophy and during other types of atrophy are best demonstrated by experiments in which, for the same animal, potassium and sodium were determined for a denervated and an immobilized or tenotomied gastrocnemius (chart 5 and 6). In true disuse atrophy, the changes in potassium and sodium were often distinctively smaller than those theoretically calculated from the increase in connective tissue. This probably indicates that the figure of 15 per cent initial connective tissue space is somewhat too high.

The increase in potassium observed during the first days of denervation atrophy and during even later stages of tenotomy and disuse atrophy may possibly be attributed to complete rest of the muscles, while the control

13. Fenn, W. O., and Cobb, D. M.: Am. J. Physiol. 115:345, 1936. Footnote 5 d.
14. Steinbach, H. B.: J. Biol. Chem. 133:695, 1940; J. Cell. & Comp. Physiol. 24:291, 1944. Fenn.6

muscles may lose potassium by the excess activity forced upon them. That increased activity temporarily diminishes the potassium content of normal muscle is well established.[15]

Since the loss of potassium during denervation atrophy varies so much from animal to animal, one might expect that a similar large variation would be observed when comparing treated with nontreated denervated muscles. However, the experimental data for this series showed a relatively uniform increase of potassium content due to treatment. As mentioned before, the large variation in per cent loss of potassium during denervation is due to the fact that muscles with an initial low potassium content will lose only little or even no potassium when calculated for "true muscle space." In consequence, muscles denervated for the same time period have a more uniform potassium content than their normal control muscles. This relatively uniform potassium level of denervated muscles may be responsible for the

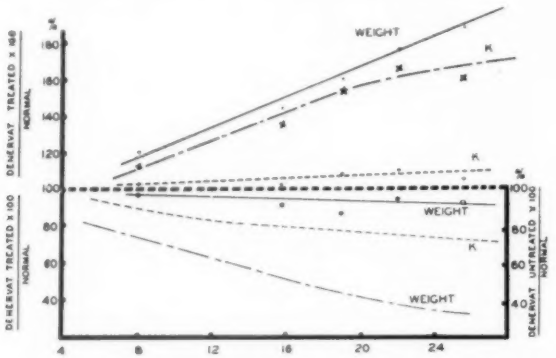

Chart 7. — Two upper curves, changes in weight and potassium by treatment expressed in per cent of the nontreated denervated control muscle. Two middle curves, changes in weight and potassium by treatment expressed in per cent of the probable weight and potassium content before denervation. Two lower curves, curves from chart 1 used to calculate probable weight and potassium content.

relatively uniform increase of potassium by the treatment procedures. Chart 7 represents mean values for the weight and potassium concentration of the treated muscles expressed in per cent of the values for the nontreated controls. The percent increase is somewhat higher for the weight than for potassium. However, these per cent increases are no measure of the efficacy of the treatment, since during denervation atrophy, as shown in chart 1, the weight decreases at a higher rate than does the potassium concentration. From the curves shown in chart 1, the probable values of the muscle weight and potassium concentration before denervation can be calculated. The two middle curves in chart 7 compare the values for the treated muscles with their probable values before denervation. On the average, the weight was returned to or maintained at about 93 per cent of the predenervation weight, while potassium was increased to about 106 per cent of the original concentration. The higher effect of the treatment upon the potassium content is probably related to the observation of Fomin[15b] and of Bruman and Jenny[16] that even in normal muscles training by electrical stimulation increases potassium content more efficiently than weight.

When judging the efficiency of our treatments,[3] one has to keep in mind that because of the large number of animals which had to be stimulated

15. (*a*) Fomin, S. W.: Biochem. Ztschr. **217**:423, 1930. (*b*) Footnote 13.
16. Bruman, F., and Jenny, F.: Arbeitsphysiol. **9**:147, 1935.

three times daily, we did not attempt perfect adjustment of the duration of the single stimuli and of the repetition frequency needed for optimal tetanus according to the actual excitability of the muscles. That such an adjustment is necessary for optimal retardation of the weight loss is well established.[17]

As can be seen from chart 8, not only is the electrical treatment very effective in preventing potassium loss or even increasing potassium concentration but it also diminishes, or prevents completely, the increase in sodium content. In consequence, the electrolyte composition of the treated denervated muscles is rather similar to that of normal muscles.

Conclusions

The observed loss in potassium and gain in sodium of the true muscle space during denervation atrophy, and the more or less complete absence

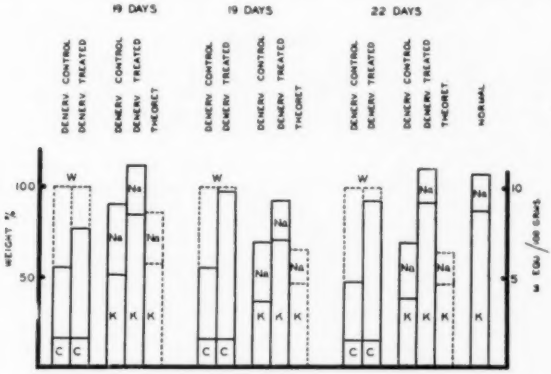

Chart 8. — Weight, potassium and sodium values for nontreated and treated muscles, nineteen and twenty-two days after denervation. The upper part of the weight bars indicates the probable weight before denervation. The last vertical bar for each experiment represents the theoretical electrolyte distribution under the assumption that all changes are due only to the relative decrease in connective tissue. The single bar represents the mean electrolyte distribution as found for normal muscle.

of such changes in atrophy following tenotomy or cast, are further proof that denervation atrophy is not only a disuse atrophy, although the rate of weight loss for true disuse atrophy is practically as high as for the first weeks of denervation atrophy.[18] The observed electrolyte changes are qualitatively the same as those observed by Fenn and Goettsch[19] in nutritional muscular dystrophy of the rabbit. If one accepts their values for true muscle space as calculated from their chlorine determinations, then the changes observed during denervation atrophy and nutritional dystrophy are even quantitatively the same.

The experiments comparing denervated with normal muscles, as well as those comparing treated denervated with nontreated denervated muscles, reveal that the potassium content of the muscle fiber is governed by many factors. During denervation atrophy, the potassium content does not drop under a certain minimum, and the level of this minimum seems to be dependent on the amount of extractable myosin still present. In this way, a constant minimal ratio of potassium to extractable myosin is maintained. Treatment of the denervated muscle increases the ratio far above this mini-

17. Fischer, E.: Am. J. Physiol. **127**:605, 1939. Grodins, F. S.; Osborne, S. L.; Johnson, F. R., and Ivy, A. C.: Am. J. Physiol. **142**:216, 1944.
18. Eccles, J. C.; M. J. Australia **1**:573, 1941. Solandt, D. Y., and Magladery, J. W.: J. Neurophysiol. **5**:373, 1942. Solandt, D. Y.; Partridge, R. C., and Hunter, J.: ibid. **6**:17, 1943. Fischer.3b
19. Fenn, W. O., and Goettsch, M.: J. Biol. Chem. **120**:41, 1937.

mal ratio; this effect might be due to increased glycogen storage and other general training effects.[20]

Summary

During denervation atrophy, after a short transient increase, the potassium content of the true muscle space diminishes progressively. In this later stage of denervation atrophy, a fairly constant ratio between potassium and extractable myosin is maintained. Sodium replaces, at least partially, the lost potassium. These electrolyte changes are typical for denervation atrophy, since such changes are nearly completely absent in atrophy following tenotomy or immobilization by cast.

Appropriate daily electrical treatment of denervated muscles prevents the potassium loss or even increases the potassium concentration above normal values. In consequence, the sodium concentration also remains at normal level.

Discussion

Dr. William L. Howell (Washington, D. C.): There have been so many developments in this field of muscle research in the past few years that it is rather difficult for one specializing in internal medicine to keep up with all of them, even when one is perhaps a little more than usually interested in physiology.

To get some idea of the rapid advances in this field, one has but to look at Dr. Fischer's bibliography. In 1944 he described the altered physiochemical properties of protein extract from denervated muscle as compared with that from normal muscle. Shortly after this, further work furnished a probable explanation: that there are two proteins in active muscle, myogen and myosin, and in the denervated muscle there is a disproportionate loss of myosin.

In his measurements showing sodium-potassium exchange, Dr. Fischer has given valuable additional evidence, I think, to show that sodium on occasion may replace potassium. It has been shown, I believe, in animals on potassium-deficient diets and also in muscles of animals during active muscle contraction that sodium may replace potassium.

The reversibility of this ion exchange has been questioned by some, and in view of this, it occurred to me that possibly further study, using the technic used by Dr. Fischer and studying the potassium content of muscles at varying intervals (that is, when treatment has been started) following denervation, might throw some light on the reversibility of this ion exchange.

Dr. Fischer has allowed for a relative increase in fibrous tissue, which, even if it were large in the beginning, could not affect his results, his conclusions. I wondered about the possibility of an absolute increase in fibrous tissue in view of the fact that Altschul described metaplasia of muscle fibers in connective tissues and the development of fibroblasts in subsarcolemnal nuclei in denervated muscle. He also showed rather marked fatty infiltration in some of these muscles. He pointed out that these changes varied a great deal from muscle to muscle and from species to species. While his studies were done some forty days following denervation, the microscopic changes which he showed in his paper were considerable. Therefore, I wonder whether it would not be well to know whether or not and when and to what degree these changes take place in the gastrocnemius of the rabbit, the muscle that I believe Dr. Fischer used.

I wonder whether the normal muscles on one side were used as controls for the denervated muscles on the other in determining the rate of potassium loss in denervated muscles.

I think that Dr. Fischer's paper is also important in that it seems that the potassium content of the muscle is not wholly dependent on the myosin content. This is against the idea that potassium binding by protein is responsible for its selective uptake.

Finally, the fact that Dr. Fischer was able to show improved potassium retention in these muscles under treatment would seem to indicate that the potassium metabolism is bound up with active metabolic processes which are incident to muscle contraction.

Dr. Fischer (closing): It is very difficult to judge from histologic slides of denervated muscles whether there is a true proliferation of connective tissue or only a relative increase. In another series of experiments, in which I determined the total collagen content of a muscle during denervation, there was no evidence of an absolute increase in collagen. The data indicated even a small loss, but the latter was inside the experimental error. Since the collagen content is a fair index of the connective tissue space, I conclude that no proliferation of connective tissues occurs during denervation. What we see in the histologic picture is only a relative increase. I might mention that in normal rabbits there is in every respect only very little difference between the left and the right gastrocnemius.

20. Palladin, A. V.: Science **102**:576, 1945.

INSTRUMENTATION IN RELATION TO ELECTROMYOGRAPHY *

I. Factors Influencing Recording and Interpretation of Electromyograms

R. PLATO SCHWARTZ, M.D.
ARTHUR L. HEATH, B.S.
and
FREDERICK W. HUDSON
ROCHESTER, N. Y.

During the past few years there has been a revival of clinical emphasis on problems provoked by neuromuscular disabilities. In relation to these efforts, electromyograms have been frequently used to improve understanding of the dysfunction of muscles due to lesions of the motor pathways of the nervous system. As a part of this trend, it is noted that variations in instrumentation, recording technics and methods of analysis are associated with prevailing differences of opinion regarding the clinical value of electromyograms. The purpose of this paper is (1) to discuss the significance of these variables, (2) to present methods which modify or eliminate them and (3) to emphasize the indication for a definition and/or recorded evidence of the pertinent factors which influence the characteristics of electromyograms as related to clinical problems.

Simplicity and economy of operation have prompted the relatively wide use of the encephalograph for electromyography. Instruments manufactured by Offner Electronics, Inc., and Albert M. Grass are among those most frequently used for this purpose. This discussion and the records presented herewith are limited to the Offner equipment, although we believe that the general principles apply directly to other similar types of recording instruments.

It is generally recognized that three basic components comprise any equipment suitable for the recording of electromyograms. These are (1) an electrode which will effectively transmit the electrical impulse from the muscle; (2) an amplifier to provide sufficient power to activate (3) some form of mechanism for recording the impulse from the amplifier. Each of these components may provoke the presence of artefacts in a record. For this reason, there is need for the most careful standardization of each component and maintenance of consistent application of uniform procedure to obtain comparable recordings.

Standardization

Electrodes. — Uniformity in the characteristics and placement of skin electrodes has not been established. Those used in making the records presented herewith were cupped disks of Monel metal, 1 cm. in diameter. Electrode jelly was used in all instances, and the electrodes were affixed to the skin by either collodion or cellulose tape. Distances between electrodes were governed by the muscle involved, 2¾ inches being average for muscle to muscle recording on adult subjects. These procedures have been found to

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* Aided by a grant from the National Foundation for Infantile Paralysis, Inc.

be both the simplest and the most efficient of the many different methods tried since 1942.

Amplifiers. — Before attempting to make records of any kind, it is essential that the amplifiers be in balance and calibrated to some known input voltage. For the benefit of those who have not previously worked closely with such equipment, the term "balance" may require some explanation. The amplifiers are designed to respond to differential impulses arising between the two electrodes used, but they will also respond to impulses arising outside the area encompassed by the electrodes. Such extraneous impulses are effectively canceled through the use of a balanced push-pull circuit. When an amplifier is in balance, the two sides of the push-pull circuit produce equal amplification of such extraneous impulses, so that they are canceled and do not appear in the output. It is evident that maximum protection against the recording of extraneous impulses is provided when the amplifiers are most nearly perfectly balanced.

The attainment of satisfactory balance is primarily a matter of careful selection of tubes with equal characteristics for use in respective push-pull

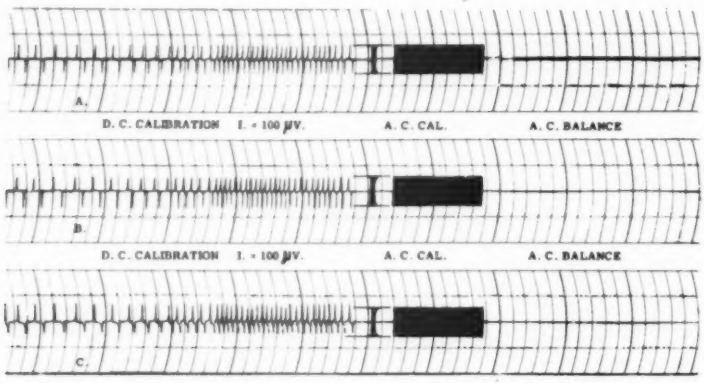

Chart 1. — Alternating and direct current calibration and balance check used in amplifier standardization; examples of symmetrical and asymmetrical calibration.

halves of each amplification stage. It is generally satisfactory to make selection of tubes on the basis of the Gm rating found on most tube testers, since this rating provides the best index of the general condition of the tube. It should be stated here that it is difficult to obtain tubes of identical Gm rating and that a small variation between tubes in the same amplification stage will usually provide satisfactory results.

For those using Offner equipment a quantitative definition of the maximum allowable unbalance is provided by the manufacturer. If the amplitude of the unbalance recorded does not exceed one-half of the recorded amplitude of a 30 microvolt input signal, the unbalance is less than 1 per cent of the total record obtained. Examples are shown in chart 1, which reveals satisfactory A. C. balance on all channels. These records were calibrated at a setting of 100 microvolts equal to 1 cm.

Channels *B* and *C* in chart 1 reveal asymmetry of the direct current calibration with respect to the alternating current calibration. This is accompanied by some variation between the direct and alternating current amplitudes. The asymmetry of the direct current calibration results from

deterioration of the neoprene blocks used in the mounting of the crystal in the penmotor. Deterioration is particularly likely to occur in those units manufactured during the period of wartime shortage, which forced the substitution of neoprene blocks for natural rubber.

It is essential that the frequency response of the amplifier and penmotor be as nearly linear as possible. A simple check is provided by calibrating respective channels using a 60 cycle alternating current input signal followed by a low frequency direct current impulse. If the frequency characteristic of the unit is flat through this range, the amplitude of the direct and the alternating current calibration will be equal, as shown in channel *A* of chart 1. If one is larger than the other, the frequency response is not linear and may often be improved by adjustment of the damping controls provided.

Comparative analysis of multiple recordings requires that the amplification factor of respective channels be linear and that the amplitude of respective channels be comparable. The Offner encephalograph is said to provide a linear amplification control at gains of 1 through 5 inclusive with an in-

TABLE 1. — *Input Voltage vs. Output Voltage (Peak to Peak)*

Input, μv.		Gain Setting									
Base to Peak	Peak to Peak	1	2	3	4	5	6	7	8	9	10
3	6	.....	.....	.....	.....	.....	10	13	21	35	52
10	20	.....	.....	6	8	12	20	35	61	100	150
30	60	5	8	12	18	32	56	95	150	170	200
100	200	12	19	34	54	96	150	180	200	.....	.....
300	600	33	56	92	140	180	200	.....	.....	.....	.....
1000	2000	95	150	180	200	.....	.....	.....	.....	.....	.....
3000	6000	170	200	+200	.....	.....	.....	.....	.....	.....	.....

crease of 5 decibles per gain step. The theoretical deviation from this value is given as less than 1 decibel.

Since the equalizer is a potentiometer, recalibration is required for accurate regaining of a previously used setting. For this reason all values in table 1 were obtained with the equalizer control out — i. e., turned to the extreme clockwise position. It should also be noted that the peak grid bias voltage of the 6SN7 tube of the 110 amplifier is 22 volts and that any input resulting in higher grid voltages causes overdriving and consequent output distortion.

The output voltage of each gain setting is defined by the manufacturer as 60 per cent of the next higher setting. In table 1 the input and output voltages of the Offner 140 A amplifier are compared. Output voltages were taken at the grid of the 6SN7 tube in the 110 amplifier.

Although the 140 A amplifiers are shown in table 1 to be essentially linear with respect to gain and input changes, several factors combine to impair the linearity of the penmotor record. Limited penmotor response and distortion resulting from overdriving the 110 amplifier produce the penmotor amplitudes revealed in table 2. It is evident from these comparisons that the 140 A amplifier is far more linear in its response than are the penmotors whose linear range is extremely short.

Table 1, table 2 and chart 2 reveal the importance of the selection of a gain setting consistent with the type of recording desired. It is evident from these data that a definite relationship exists between gain settings, input voltage and the overload point of the amplifier and penmotor. Obviously beyond this overload point any increase in the input potential is not revealed by increased record amplitude.

Chart 2 presents examples of response to varying input voltages. At gain 1 (chart 2 *A*) no record was obtained with input voltages less than 100 microvolts, and the overload point of the penmotors is reached between 1,000 and 3,000 microvolts. Chart 2 *B*, recorded at gain 6, records impulses as low as 3 microvolts but reaches the overload point at approximately 100 microvolts. Observations made with the cathode ray oscillograph indicate that the overload point of the 140 A amplifiers is higher than that of the 110 amplifier and penmotor.

After the amplifiers have been calibrated at the desired gain setting, it is important to know that all penmotors are responding to all input values consistent with the gains selected (table 1). Chart 5 presents records obtained from two penmotors satisfactorily calibrated at 30 microvolts, gain 5.

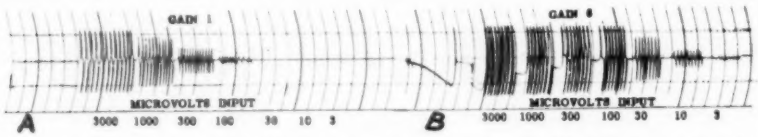

Chart 2. — Record amplitude obtained with direct current input of 3 to 3,000 microvolts at gain settings of 1 and 6.

TABLE 2. — *Input Voltage vs. Penmotor Deflection (Calibration 5 mm. to 30 Microvolts)*

	Gain Setting									
Input μv.	1	2	3	4	5	6	7	8	9	10
3	0	0	0	0	0	1	3.5	5	10	16
10	0	0	0	1	3	6	10.5	15	20.5	25
30	0	1	2.5	5	10	15	20	24	25	26.5
100	3	6	10.5	15	20.5	25	26	26.5	26.5	26.5
300	10	15.5	20	24.5	26	26	26.5	26.5	26.5	26.5
1000	20	25	26	26	26	26.5	26.5	26.5	26.5	26.5
3000	26	26	26.5	26.5	26.5	26.5	26.5	26.5	26.5	26.5

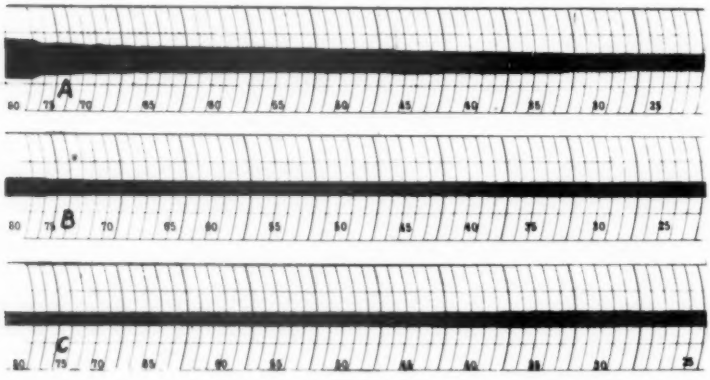

Chart 3. — Frequency response of penmotors at 25 to 75 cycles inclusive. *A*, undamped record with old pen; *B*, damped record with old pen; *C*, undamped record with new pen.

Although the responses of these two penmotors were identical at 30 microvolts, it is evident in chart 5 *A* that one penmotor did not respond uniformly to a 10 microvolt input at the same gain. Such failure to respond to low level input could, of course, prevent the recording of low grade motor unit activity.

The Offner amplifiers are equipped with a selector switch to permit elimination of undesirable frequencies by changing condenser values. Respective condenser settings establish the following low frequency limits:

Condenser Setting	Frequency
0.5	0.1 cycle per second
0.2	0.16 cycle per second
0.02	0.9 cycle per second
0.002	8.0 cycles per second

Two "Lo" condenser settings of 0.02 and 0.002 have proved most useful. As revealed in chart 6, it is necessary to use "Lo" condenser setting 0.002 to obtain maximum freedom from low frequency impulses resulting from

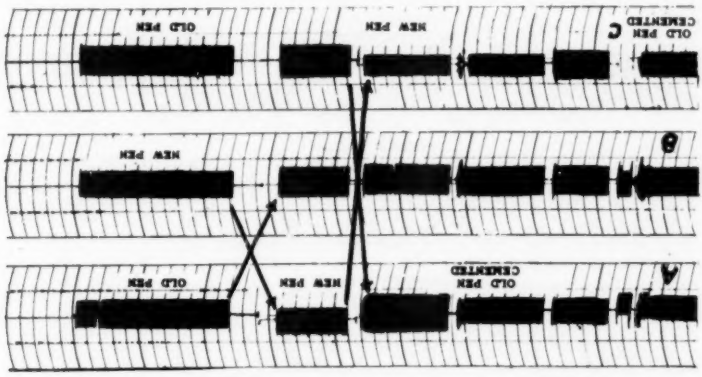

Chart 4. — Sixty cycle calibration with (*A*) old unstabilized pen, (*B*) old stabilized pen and (*C*) new pen.

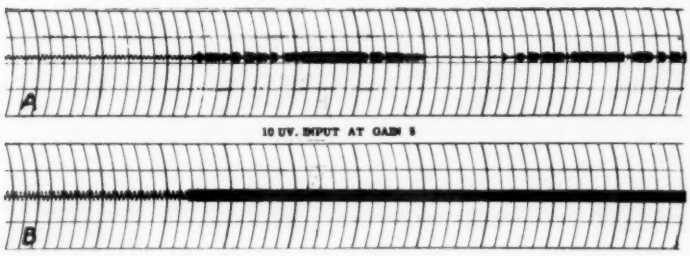

Chart 5. — Sixty cycle calibration record showing (*A*) failure of penmotor to respond to 10 microvolt input and (*B*) normal penmotor response to same input.

postural changes or necessary movements of extremities. The resulting attenuation of low frequency impulses, however, reduces the amplitude of the record and distorts the low frequency wave form. It is therefore desirable to use "Lo" setting 0.02 whenever possible.

Control of amplifier response to high frequency input is provided by a second ("Hi") series of condensers. These begin to reduce amplifier response at the following respective frequencies:

Condenser Setting	Frequency
0	2,000 cycles per second
1	125 cycles per second
2	50 cycles per second
3	15 cycles per second

Penmotors. — It is also essential that consideration be given to those factors known to influence the frequency response of the penmotor recorders. Chart 3 presents three records of frequency response from 25 through 80 cycles inclusive. Record 3*A* reveals a distortion producing approximately twice the deflection at 75 cycles as that obtained at 25 cycles. This record was made with an unchecked Offner penmotor, undamped, that had been in use for some months. Through the use of the damping controls provided, the frequency response throughout the range referred to was improved as shown

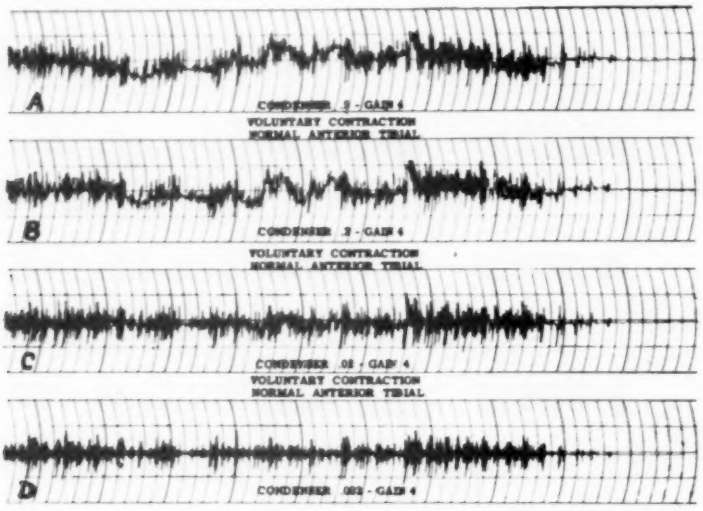

Chart 6. — Effect of various condenser settings on base line fluctuation.

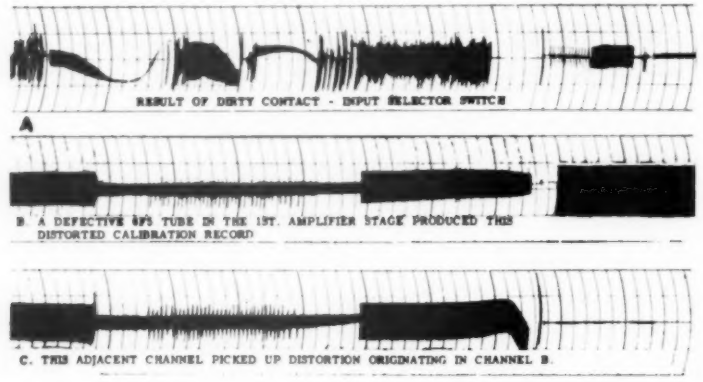

Chart 7. — Artefacts resulting from defective amplifier operation.

in chart 3*B*. Although the response is more linear through the frequency range shown, excessive use of the damping controls may result in reduction of the amplitude of the record. The Offner manual, however, indicates that the frequency response of the penmotors should be essentially linear from 0 to 100 cycles. An effort was therefore made to define the cause of the nonlinearity revealed in chart 3*A*. Subsequent tests indicated that the fre-

quency distortion shown resulted from pen whip. After continuous use there is a tendency for the capillary tube of the writing pen to become loose in the suspension mount.[1] Looseness at this level permits whip of increasing magnitude as the frequency is increased. This difficulty can be eliminated by frequent checking of the pens and, when necessary, the application of a small quantity of collodion or Du Pont cement at the ends and the midpoint of the pen mount. The additional weight resulting from such cementing

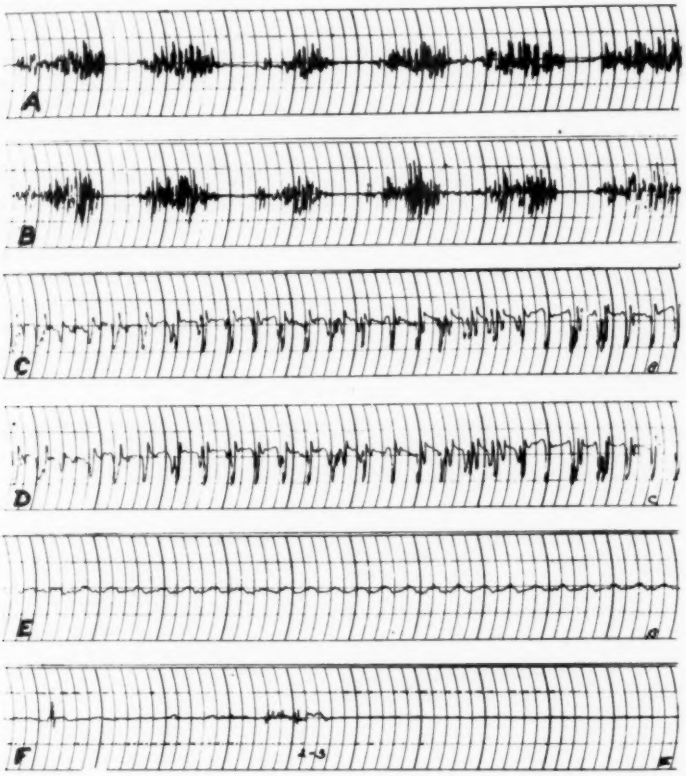

Chart 8. — Artefacts produced by disturbance of electrode leads. *A* and *B*, gentle brushing of unshielded electrode leads; *C*, movement of shielded lead, not grounded; *D*, induced artefact from C; *E*, movement of shielded grounded lead; *F*, vigorous agitation of multiconductor input cable.

is negligible when compared to the improvement in the frequency response obtained. Chart 4 clearly reveals the differences in the amplitude of a 100 microvolt signal when recorded by (1) an old pen, (2) an old pen stabilized by application of collodion and (3) a new, stable pen. Pens were moved from one channel to another to demonstrate that the effect was the same regardless of the channel used.

Artefacts. — Chart 7 *A* illustrates a type of artefact that may be easily confused with a muscle action record. In this instance the artefact resulted from poor contact of an input selector switch. An artefact of similar characteristics can be produced by a poor or dirty contact on the gain selector switch. Con-

1. We are informed that the Offner Company is changing the method of cementing to improve pen life and stability.

sequently care should be taken to keep these switches in such condition that changes between respective gain and input values can be made smoothly and without distortion of the calibration record. It has been found helpful to inspect gain switches periodically and to clean individual contact surfaces with carbon tetrachloride and a fine brush.

Record 7 *B* reveals an artefact obtained in association with a defective 6F5 tube in the first amplifier stage. It is interesting to note that, although the defective tube was found in channel *B*, channel *C* reveals evidence of pick-up of distortion originating in channel *B*.

Artefacts may originate in relation to the leads connecting electrodes to the terminal box. Chart 8, records *A* and *B*, reveals the type of artefact produced by drawing a thin strip of paper gently across unshielded electrode leads. The similarity between the appearance of this type of artefact and the record produced by voluntary muscle contraction is self evident. Record 8 *C* reveals artefacts produced by moderate movement of a shielded electrode lead (the shield was not connected to the ground). Care was taken to immobilize the electrode itself by means of finger pressure. The finger was completely insulated from the electrode. It is interesting to note that chart 8 *D* reveals the same type of artefact as revealed in 8 *C*, although the electrode activating channel *D* was not simultaneously agitated.

The same procedure was carried out to produce record 8 *E*. The difference in the type of record obtained resulted from grounding of the electrode wire shield.

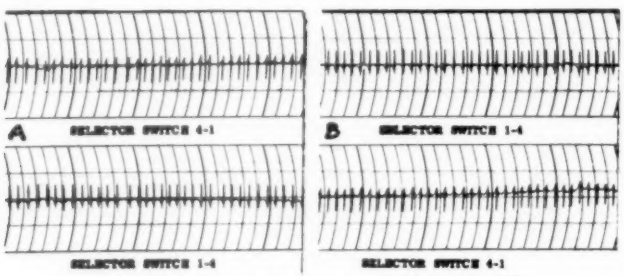

Chart 9. — Effect of reversal of input polarity to amplifier.

Record 8 *F* reveals that vigorous agitation of the multiconductor shielded cable leading from the terminal box to the input of the amplifier represents much less a hazard than does agitation of the electrode leads. The presence of artefacts such as those described in chart 8 are important if the extremity involved is permitted to move during the taking of the records.

Offner amplifiers include a group of selector switches which make it possible to record any combination of electrodes on the desired penmotor channel. The ability to switch circuits instantly is valuable in making many types of comparisons. Care should be taken, however, to standardize the setting of the electrode selector switches so that the polarity remains constant. Polarity reversal results in inversion of the record as shown in chart 9. Ordinarily this may not be of great importance in the interpretation of myograms, but it is particularly advisable to maintain a constant polarity when comparative records are being made of various sections of the same muscle.

Many of the procedures discussed in this paper may seem to be obvious and unnecessary to persons who have had long experience in the recording

of electromyograms. However, the publication of all data pertaining to prevailing differences in instrumentation, recording technic and interpretation would facilitate better understanding of records from different sources.

Chart 10 provides evidence of the need for careful consideration of all known factors affecting the function of the amplifiers before making records. Six channels were calibrated to provide equal outputs from equal input voltages as shown in chart 10*A*. The variable responses of these channels to a uniform frequency is shown in chart 10*B*. The test was conducted at frequencies from 25 to 80 cycles per second; the response shown at 45 cycles is representative. Electromyograms were then taken of the voluntary contraction of a normal anterior tibial muscle and recorded simultaneously on all six channels (chart 10*C*). The variation in the appearance of the record on

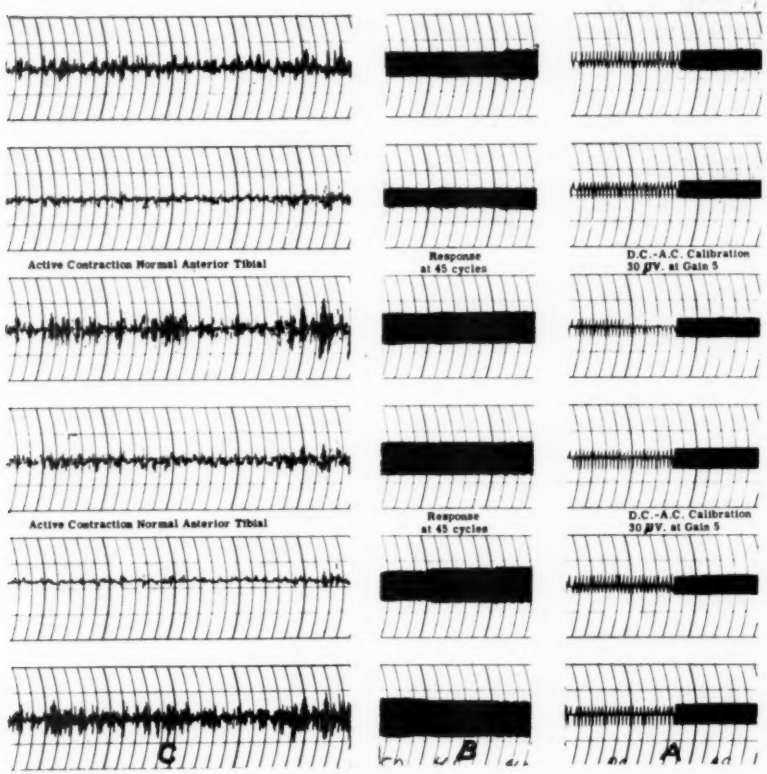

Chart 10. — Electromyograms of contraction of normal anterior tibial muscle. *A*, alternate and direct current calibration; *B*, frequency response; *C*, response of six unstandardized penmotors to a common muscle action impulse.

respective channels indicates the difficulty experienced in trying to make a valid interpretation. The nonuniformity of respective records in this instance can be accounted for on the basis of the following factors: (1) deterioration of rubber blocks supporting the crystals in the penmotor (this condition can be recognized by the asymmetrical appearance of the direct current calibration shown in chart 1*B* and *C*); (2) varying degrees of pen whip on different channels, indicated by the width of the band resulting from a 45 cycle input

(charts 3 and 4). Comparison of these characteristics with those revealed in chart 11 provides definite evidence of the advantage of maintaining a continuous check on the equipment used. Alternating and direct current calibration values were equal to those used to obtain record 10 *A*. Frequency response shown in chart 11 corresponds well with the calibration values shown and is a typical section from a continuous calibrated record revealing complete linearity between 25 and 80 cycles per second (chart 3 *C*). Record 11 *C* reveals uniformity of the response of all channels to the voluntary contraction of a normal muscle. Uniformity of response is demonstrated by comparison of patterns appearing synchronously in records made by respective

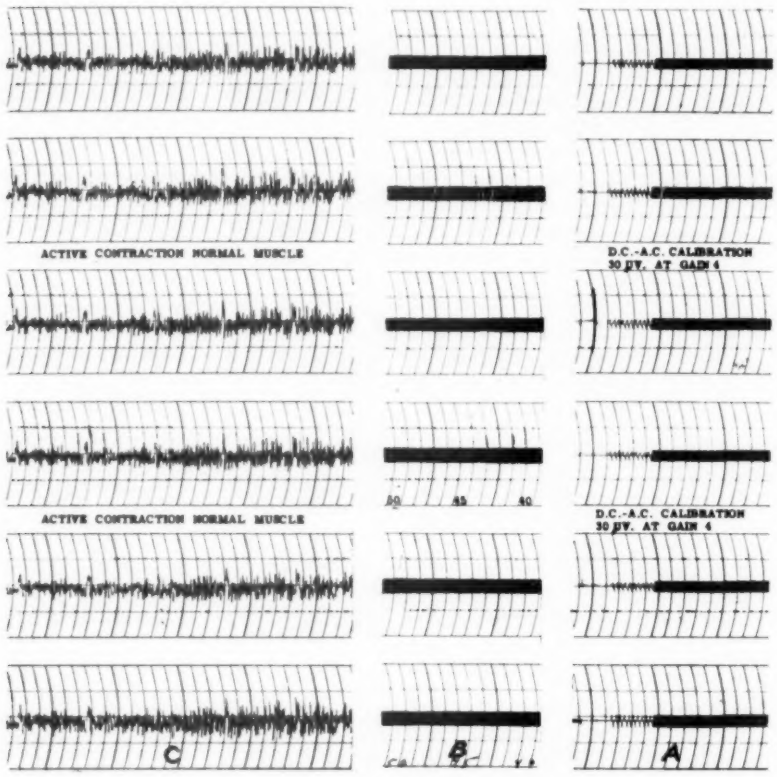

Chart 11. — Alternate and direct current calibration, frequency response and response of six standardized penmotors to a common muscle contraction.

channels. It is clearly evident that constant control of all factors affecting the recording instrument increases the reliability of the records obtained. The increased fidelity demonstrated was obtained by replacement of deteriorated neoprene blocks supporting the crystals within the penmotor and by installation of new pens free from whip.

Agreement has not been reached among workers in this field regarding optimum rate of paper travel. Some believe that minimum paper travel (0.5 to 1 cm. per second) is satisfactory. Such recordings, of course, have the disadvantage of concealment of the pattern resulting from various types of

motor unit activity. Furthermore, they do not permit visualization of the proportion of high and low peaks comprising a record. Other workers feel that a more detailed expression of motor unit activity is obtained by a recording at a rate of paper travel of 25 cm. or more per second. Chart 12 provides a composite comparison of the differences in the appearance of a sustained voluntary contraction of a normal muscle recorded at paper speeds of 0.5 to 25 cm. per second.

Similarly, the optimum gain setting used for various types of recording is at present a matter of individual judgment. Table 1 reveals the need for compromise in this matter. It is evident that the lower gain settings (1 or 2) sacrifice recorded evidence of low voltage input for the purpose of ob-

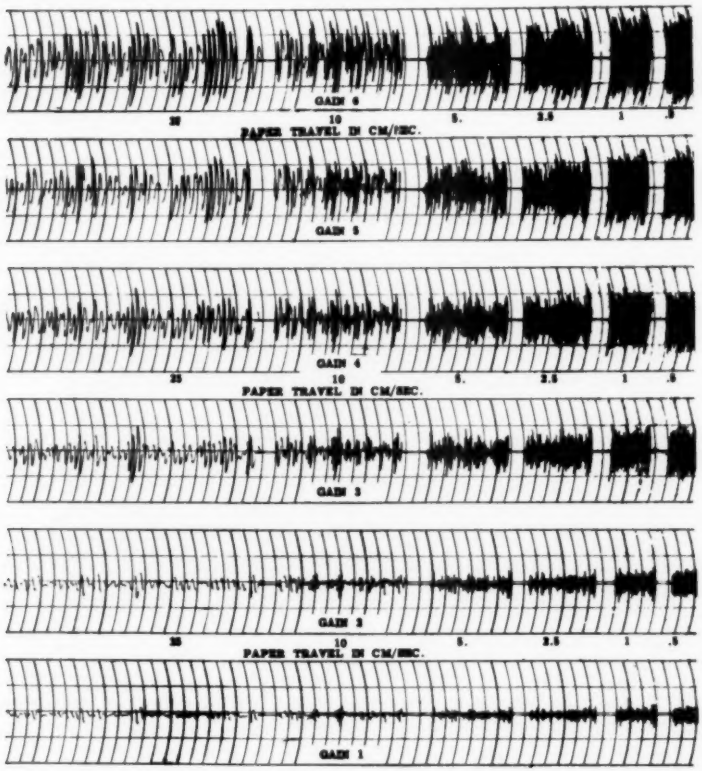

Chart 12. — Changes in appearance of the same muscle contraction recorded at different gains and paper speeds.

taining a valid recording of high voltage input without cutoff. The reverse situation prevails when high gain settings (5 or 6) are used. The appearance of the same normal muscle contraction recorded simultaneously at gains of 1 through 6 is shown in chart 12.

Within the scope of this discussion we have indicated pertinent factors which influence accurate recording and interpretation of electromyograms as applied to clinical problems. The procedures as stated include recognition of the limitations of the instrumentation as specified. In a succeeding article

on this subject further consideration will be given to the limits of such instrumentation.

Conclusions

1. Prevailing differences in instrumentation, recording technic and interpretation in electromyography foster divergent opinions regarding the clinical value of electromyography.

2. The inclusion of all data pertaining to these three potential variables in published reports would facilitate better understanding of conclusions reached by different authors.

3. Definition of the limitations of any electromyographic recorder with respect to frequency response, linear amplification, balance and calibration is an essential prerequisite to valid records.

4. Constant care is essential in all electromyographic procedures if confusing artefacts are to be avoided.

INSTRUMENTATION IN RELATION TO ELECTROMYOGRAPHY *

II. A Discussion of Instrumentation Requirements for High Fidelity Electromyographic Recording Using Skin Electrodes

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ARTHUR L. HEATH, B.S.
and
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ROCHESTER, N. Y.

In part I of this study certain precautions were emphasized for the maintenance of high fidelity electromyographic recording within the limits of the amplifiers and penmotors used.[1] It is the purpose of the present paper to state the dominant factors present in electromyographic records made with skin electrodes and to discuss the characteristics of available types of recorders in relation to these requirements. Most widely used are electroencephalographs manufactured by Offner Electronics, Inc., and Albert M. Grass. The former was used in conducting these tests. However, since the characteristics of different instruments are similar, the conclusions herein presented should prove helpful regardless of the particular instrument used.

Two measurable characteristics of electromyographic impulses define the requirements of the recording instrument. These are voltage and frequency. Considering these in order, it is recognized that five variables significantly affect the input voltage to the amplifier. These are (1) type of skin electrode; (2) electrode area; (3) distance between electrodes; (4) strength of contraction (voltage output); (5) power of the muscle.

* From The Department of Surgery, Division of Orthopedics, The University of Rochester School of Medicine and Dentistry.
* Aided by a Grant from The National Foundation for Infantile Paralysis, Inc.
1. Schwartz, R. Plato; Heath, Arthur L., and Hudson, Frederick, W.: Instrumentation in Relation to Electromyography: I. Factors Influencing Recording and Interpretation of Electromyograms, Arch. Phys. Med., this issue, p. 383.

Because of the wide range of potential combinations of these five variables, it is possible only to indicate the extreme range of input that can be reasonably anticipated. Using the skin electrodes previously described, input voltages to 5 millivolts have been recorded from a normal muscle. It is therefore evident that electromyographic recording equipment for use with the skin electrodes should be linear to at least that value.

Through records of strong voluntary contractions of normal muscles (fig. 1) it is possible to be relatively specific in defining the frequency requirements for high fidelity electromyographic recording using skin electrodes. To establish the minimum impulse duration, the recorded myogram was interrupted 5,000 times per second. The duration of any impulse can be obtained by taking the number of interruptions occurring in any deflection, counting from base line to base line. Since each spike can be considered as one half of a cycle, multiplication of the number of interruptions by two provides data from which the corresponding sine wave frequency can be obtained. Such data from figure 1 are shown in the following tabulation:

	Impulse Duration, Milliseconds	Cycle Duration, Milliseconds	Corresponding Sine Wave Frequency, Cycles/Second
(1)	1.5	3.0	330
(2)	3.7	7.4	130
(3)	2.4	4.8	200
(4)	2.6	5.2	190

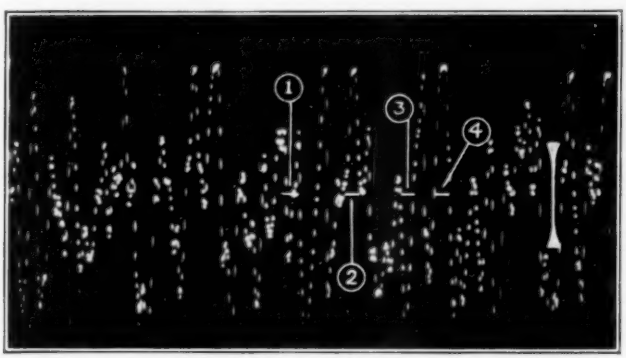

Fig. 1. — Enlarged section of electromyogram recorded on cathode ray oscilloscope with 5,000 cycle timing interruption. Calibration indicates 2,000 microvolts.

The highest impulse frequency shown corresponds to a sine wave frequency of 330 cycles per second. Careful examination of the record, however, reveals higher frequency compounds. Calculations from observed data show that these approach 600 cycles per second.

It is, of course, desirable to provide means for the elimination of low frequency impulses (0 to 15 cycles per second) resulting from postural changes and necessary movements of extremities. Instrumentation capable of flat frequency response from 15 to at least 600 cycles per second is required for clinical electromyography using skin electrodes. Additional latitude for experimental recording is desirable.

The frequency response of the "Crystograph" and amplifier was determined by the use of an oscillator as a variable frequency input. Figure 2 presents three curves showing (*a*) the uniformity of output of the oscillator

used; (*b*) the response of the Offner amplifier to various frequencies as revealed by the oscilloscope; (*c*) the penmotor frequency response.

It should be stated that the drop in the response curve of the amplifiers between 0 and 200 cycles occurs because of the "Lo" condenser setting (0.002) selected for these tests (fig. 3). Attenuation of low frequencies can be minimized by using larger "Lo" condenser settings.

These requirements for high fidelity electromyographic recording having been defined, it is necessary to consider the character of available instrumentation in relation to these known requirements. The term instrumentation has been previously used to include both the amplifiers and the recording instrument. In the interest of clarity it is now desirable to consider these as separate units.

Amplifiers

Data presented in table 1 of part I of this study[1] define linearity of re-

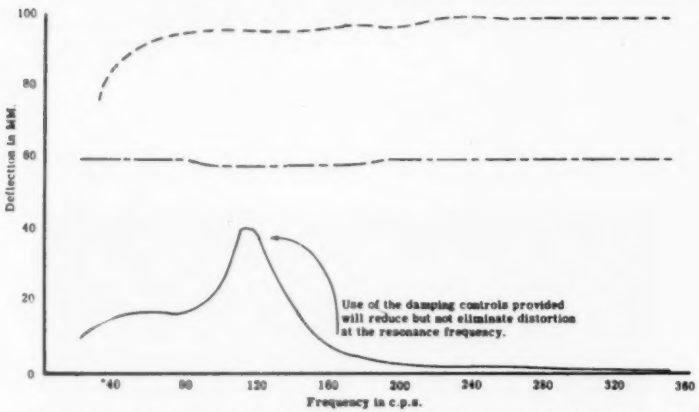

Fig. 2. — Frequency response: top curve, Offner amplifiers — oscillograph deflection; middle curve, oscillator — oscillograph deflection; bottom curve, Crystograph — penmotor deflection.

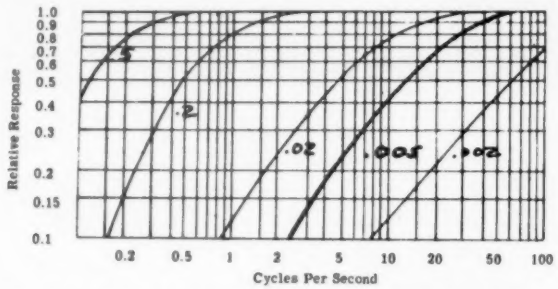

Fig. 3. — Advantages from use of condenser setting 0.005. To obtain greater freedom from base line fluctuations with minimum attenuation of electromyographic frequencies, a condenser value 0.005 was substituted for 0.002. The low frequency cut-off point has been raised from 0.8 to 2.5 cycles per second, and the 100 response is reached at 60 instead of 200 cycles per second.

spective gain steps when the equalizer control is not used. However, since the equalizer control is a continuously variable attenuator effective over the entire range of the amplifier, its use alters the sensitivity of respective gain settings.

Understanding of the frequency characteristics of the amplifiers is of prime importance. Two aspects of the problem require consideration: (1) the frequency range through which the amplifier response is flat, and (2) maximum attenuation of undesirable frequencies without attenuation of those frequencies to be recorded.

Data provided by the manufacturer reveals that at their widest range (condenser setting Lo — 5, Hi — 0) the Offner 140A amplifiers provide flat frequency response from 0.7 to 2,000 cycles per second. It has previously been emphasized, however, that a Lo condenser setting of 0.002 is required to minimize low frequency impulses due to postural changes. However, there is also present undesirable attenuation of frequencies to approximately 200 cycles per second (fig. 3). When such movements can be prevented, Lo condenser setting 0.02, which permits 100 per cent response above 25 cycles per second, is considered preferable for electromyographic recording with skin electrodes.

To obtain maximum freedom from base line fluctuation with minimum attenuation of electromyographic frequencies, a compromise condenser value between 0.02 and 0.002 was substituted. Figure 3 reveals the advantages gained through the use of the new condenser setting 0.005.

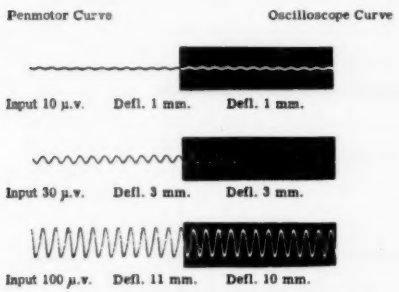

Fig. 4. — Sixty cycle calibration curves at 10, 30 and 100 microvolt input as recorded by penmotor and cathode ray oscilloscope.

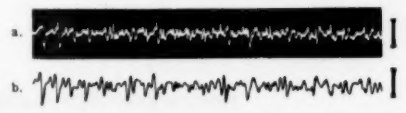

Fig. 5. — Record of moderate contraction of normal muscle by (*a*) cathode ray oscilloscope and (*b*) Offner penmotor. Calibration indicates 2,000 microvolts.

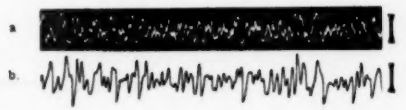

Fig. 6. — Record of strong contraction of normal muscle by (*a*) cathode ray oscilloscope and (*b*) Offner penmotor; frequency and amplitude distortion are clearly evident. Calibration indicates 2,000 microvolts.

The Recorder

Much of the controversy in relation to electromyography has centered about the type of recorder to be used. Obviously the inertia-free cathode ray oscilloscope is best suited to the visualization and recording of high frequency impulses. Unfortunately, the difficulty and expense associated with its use for multiple recordings have limited its clinical usefulness. As a laboratory instrument, however, it provided a method of evaluating the validity of records obtained by alternate methods.

The economy and simplicity of operation of inkwriters have made them particularly attractive to persons interested in clinical myography. Both Offner and Grass employ inkwriters as a recording medium. Although the former uses crystals and the latter employs the electromagnetic type, frequency characteristics of various inkwriters are similar.

"Crystograph" records were made using standard Offner penmotors with 2¾ inch pens calibrated to provide an amplitude of 1 cm. at 100 and 300 microvolts input. Simultaneous records were made on a Type 247 Du Mont Oscilloscope calibrated to give a 5 cm. deflection at an input of 2,000 microvolts peak to peak. The oscilloscope tracing was recorded on 35 mm. film

at one-fifth actual size. By this means the various recorded deflections were comparable.

Figure 4 presents calibration recordings of a 60 cycle sine wave on respective recorders using input signals of 10, 30 and 100 microvolts. Measurement of these records reveals an identical amplitude of 1 and 3 mm. on the two instruments at 10 and 30 microvolts input. At 100 microvolts input, however, the penmotor record reveals an increase of 10 per cent in amplitude over the corresponding record produced by the cathode ray oscilloscope. Since the amplitude of successive myograms of the same muscle may be affected by a number of other conditions, the 10 per cent difference between various methods of recording is felt to be within permissible limits. With use of the instruments specified, efforts were made to compare electromyographic records made of the contraction of a normal human muscle as recorded by respective instruments (figs. 5 and 6).

To minimize distortion due to overloading of the amplifier and penmotor, the calibration scale was set at 10 mm. per 2,000 microvolts (peak to peak). Figure 5 reveals a moderate muscle contraction recorded with the cathode ray oscilloscope and inkwriter, respectively. From the calibration data previously given, it is evident that the oscilloscope record reveals a maximum muscle output of 2,200 microvolts (fig. 5). The same contraction measured

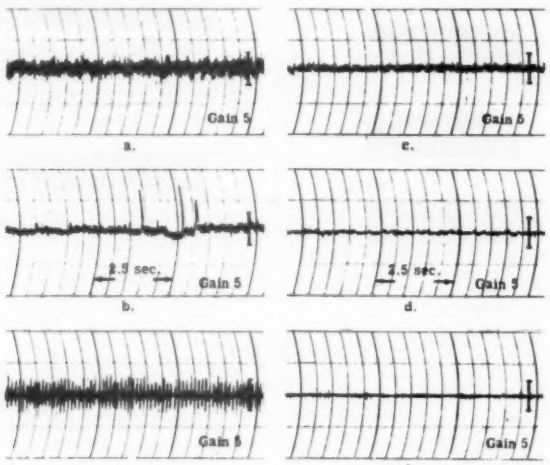

Fig. 7. — Reduction in spasm in hemiplegia (*a*, *b*, *c*, *d*) and postencephalitic parkinsonism (*e*, *f*) recorded by inkwriter. *a*, *b*, Leads from rectus femoris and biceps brachii muscles prior to oral administration of 1 Gm. of Myanesin; *c*, *d*, Leads from same muscles thirty minutes after administration of the drug. *e*, Forearm tremor prior to oral administration of 1 Gm. of Myanesin; *f*, reduction in tremor eleven minutes after administration of the drug. Calibration indicates 400 microvolts.

from the inkwriter records reveals a maximum deflection corresponding to a 2,400 microvolt input.

The consistently high amplitudes shown in figure 6*a* were obtained in association with a stronger muscle contraction than that recorded in figure 5. Although the maximum muscle output still remained at 2,200 microvolts, a larger percentage of the impulses approached that value in the strong contraction. Measurement of the same contraction recorded by the inkwriter (fig. 6*b*) reveals peaks corresponding to 3,400 microvolts. The reasons are to be found in the analysis of the frequency characteristics of the amplifier and inkwriter (fig. 2).

Figure 2 defines the limitations of the frequency response of the penmotors and suggests one reason for the distortion of high input voltages shown in figures 5*a* and 6*a*. As indicated therein, the resonant frequency of the penmotors is reached at approximately 120 cycles per second. Since any vibrating system is more sensitive to its resonant frequency than to any other, the 120 cycle component in electromyograms is sufficient to excite the resonant frequency of penmotors which increases their response to that frequency. The measured frequency of the stronger impulses shown is approximately 120 cycles per second. This suggests that the 3,400 microvolt deflection shown is a distortion of impulses occurring at 120 cycles per second and that the 2,200 microvolt value measured from the oscilloscope record is a much more reliable figure.

On the basis of comparative records presented and the accompanying analysis of electromyographic requirements, it is evident that the characteristics of inkwriters herein discussed are not those best suited for recording electromyographic wave forms. As revealed in figures 5 and 6, there is good correlation between the gross impulse patterns recorded by the cathode ray oscilloscope and the inkwriter, respectively. It is equally evident, however, that the intimate detail of wave form is distorted by the inkwriters. The use of the damping controls provided reduces, but does not eliminate, distortion at the resonant frequency. The presence of such distortion disqualifies the inkwriter for the detailed recording and analysis of wave form.

Any interpretation of electromyographic inkwriter records must, therefore, be made with full awareness of the limitations inherent in the instrument used. Such records may be definitely helpful in recording and comparing the gross pattern of muscle impulses under given conditions. Quantitative comparisons made on the basis of the varying amplitude of respective records must, however, be regarded as indexes rather than as specific measurements.

Although the frequency and amplitude response characteristics of instrumentation described herein reveal limitations as related to the total scope of electromyography, definite advantages may be gained by the application of these instruments to specific clinical problems. An example of such clinical use is provided in figure 7. The records shown are taken from a series made during a study of the effect of drug therapy on muscle spasm resulting from various causes. Analysis of the intimate detail of wave form was not essential to this investigation. It was necessary only to have a reliable index of the degree of spasm prevailing before and after administration of the drug. With the amplifiers calibrated in accordance with the procedures outlined in this discussion, the necessary data were adequately recorded.

Since string galvanometers are available with flat frequency responses to at least 2,000 cycles per second, they provide the possibility of a useful compromise. Multiple recordings can be made on photographic paper with higher fidelity than with inkwriters and at lower cost and with greater simplicity than with the cathode ray oscilloscope.

Comment

Economy and simplicity of operation are two evident advantages gained through the application of skin electrodes and inkwriter recorders to clinical electromyography. Maximum freedom from distortion, however, requires careful operation of all instruments, based on full understanding of their inherent limitations as related to the phenomena to be recorded. The calibration level and gain setting selected may exert a strong influence on the distortion level. It is important that such data be included with any presentation of electromyographic evidence. The adoption of such procedure

should facilitate better understanding of conclusions reached by various authors.

Conclusions

1. The recorded minimum impulse duration of significant amplitude is 1.5 milliseconds, corresponding to a spike frequency of 330 cycles per second.
2. Higher frequency components have been measured to 600 cycles per second.
3. Present knowledge indicates that valid electromyograms with use of skin electrodes can be made with instruments having the following characteristics: (*a*) linear input voltage response to 5 millivolts and (*b*) flat frequency response from 15 to 600 cycles per second.
4. Inkwriter and cathode ray oscilloscope records may be compared on the basis of gross characteristics when suitable gain and calibration settings are selected and when the dominant frequencies do not exceed 100 cycles per second.
5. Frequencies above 100 cycles per second are recorded with significant distortion of the amplitude of the penmotor record and, therefore, cannot be interpreted either quantitatively or qualitatively.
6. Characteristics of the amplifiers discussed herein more nearly approach fulfilment of stated electromyographic requirements than do inkwriters.
7. String galvanometers provide an effective compromise. They can assure (1) a longer frequency response range than inkwriters, (2) greater convenience and (3) greater economy than multiple cathode ray oscilloscope recordings.

SOME IMPLICATIONS OF ATOMIC ENERGY IN PHYSICAL MEDICINE *

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The controlled release of atomic energy has probably had the greatest impact on our civilization of any scientific development. The atomic bomb is the most powerful weapon in the history of armaments, and we are told that radioactive isotopes are the greatest contribution to the natural sciences since the invention of the microscope by Leeuwenhoek in the seventeenth century. It appears that greater things are still to come. A major effort is being directed toward the development of the chain-reacting uranium pile for use as a source of power in the broad applications to include nuclear power for the propulsion of ships, submarines, airplanes and other conceivable mobile units. Particle accelerators which will produce energies at the billion electron volt level are being developed, and it is anticipated that these will make available hitherto unobtainable radioisotopes. In addition, the value of high

* Read at the Twenty-Sixth Annual Session of the American Congress of Physical Medicine, Washington, D. C., Sept. 9, 1948.

speed electrons, neutrons and similar particles as therapeutic agents has not been sufficiently investigated.

Of greater personal interest to those of us here today is the fact that the application of the products of atomic energy in the biologic and medical fields is expanding rapidly. In its semiannual report to Congress,[1] the Atomic Energy Commission announced that an increasing number of institutions are using radioactive isotopes as research and therapeutic tools in the biologic and medical sciences. At this date, these radioactive isotopes are the major contribution of the Atomic Energy Commission to the biologic and medical sciences, and I shall present to you some of their applications which are related to your field of interest.

Radioactive isotopes have been used in biologic and medical research for a number of years. The first experiments were carried out with the naturally occurring radioisotopes of lead (thorium B)[2] by Hevesy in 1913. In this experiment studies were carried out on the uptake of the isotope by bean plants. Actually, some fifty naturally occurring radioisotopes are known, but only a few emit their energy over a period of time long enough to make them useful.

The discovery of artificial radioactivity by the Joliots was the impetus for rapidly expanding activity in this field. Such artificial radioactivity is produced when the constituent particles of the nucleus of the atom are added to or subtracted from the stable nuclei which occur in nature. This causes the nuclei to omit detectable radioactive emanations as particles or radiations as they return to a stable form. However, the radioactive atoms retain their original chemical properties; hence they may be used to follow the behavior of the particular element under a variety of conditions. Artificial radioactivity may be induced by bombarding the nucleus with uncharged or charged particles, the latter traveling at very high speeds. Such speeds may be generated in cyclotrons, in which the particles are accelerated by rotating them through magnetic fields at very high voltages. Through the use of the cyclotron and related apparatus, it was possible to produce some three or four hundred artificially radioactive isotopes.[3] In many ways, the uncharged particles or neutrons are the ideal tools for bombarding nuclei, for, being uncharged, they are not repelled as are the charged particles, and they have freer access to the nuclei. In the chain-reacting piles of the Atomic Energy Commission, we have a powerful neutron factory through the liberation of neutrons by uranium in the piles. In these neutron factories, we are able to produce artificial radioactive isotopes of practically all the important known isotopes in milligram, gram or even kilogram scale, whereas in previous methods the amounts were largely in the microgram range. There are still a few radioactive istopes which must be produced in the cyclotron, but those of major medical importance are practically all pile produced. Today, there are close to five hundred artificial radioactive isotopes. Each of the known 96 elements is represented by at least one artificial or natural radioactive isotope, and there is usually one whose half-life and radioactive characteristics make it suitable as a tracer isotope. The two important exceptions are oxygen and nitrogen, but, fortunately, stable isotopes of these elements are available as satisfactory research tools.

In the use of radioactive isotopes, the element which is present as a mixture of its naturally occurring stable isotopes is tagged by adding to it an adequate

1. Fourth Semiannual Report, United States Atomic Energy Commission, Washington, D. C., United States Government Printing Office, 1948.
2. Hevesy, G: The Absorption and Translocation of Lead by Plants, Biochem. J. 17:439, 1923.
3. Seaborg, G. T.: The Preparation of Radioactive Isotopes, in: Isotopes in Biology and Medicine, Madison, Wis., University of Wisconsin Press, 1948, p. 23.

amount of one of its radioisotopes. The amount feature deserves emphasis; for example, 10,000 disintegrations per minute of eight-day iodine (I^{131}), sufficient for a typical experiment, represent about 4×10^{-14} Gm. of this isotope. Thus, if this is mixed with 4 mg. of stable iodine, we have an isotope abundance of 10^{-11}. Whereas, six years ago a first rate chemist required four days to recognize one millionth gram of phosphorus, today the same chemist can recognize one millionth of a millionth gram in about five minutes. It is also worthy of note that by considering the radiation characteristics of those isotopes, it is often possible to use the radioisotopes of two different elements in the same experiment.

As of this date, a number of these radioisotopes are in use in medical research, and a brief summary may prove helpful in crystallizing your own ideas regarding opportunities for the use of such materials in your particular field of research and development.

Dr. Edith Quimby[4] has used radioactive sodium to study circulatory recovery after prolonged apnea followed by vigorous artificial respiration. Since sodium is an essential cation of the extracellular water of the body, there is rapid passage along the blood vessels and free diffusion into the extracellular spaces. Dr. Quimby has shown that the pulmonary circulation may resume after one hour of clamped trachea in dogs and that the administration of heparin will make this recovery more frequent and more rapid. The efficiency of breathing devices could be elucidated by this procedure. Sodium is a gamma ray emitter and, as such, must be carefully handled and shielded. There are two isotopes presently used: One with a half-life of 14.8 hours, pile produced, is useful for many short term experiments; the other, a cyclotron product, has a half-life of three years. Radioactive sodium has also been used in studies on the competency of the peripheral circulation in peripheral vascular diseases, with the hope that more accurate determinations of the level of occlusion might be obtained.

Radiophosphorus has had wide and varied use, from treating leukemia to studying nerve function. Using the giant axon of squid, Dr. David Nachmansohn, also of the College of Physicians and Surgeons, Columbia University,[5] has carried out interesting studies with the radioisotopes of sodium, calcium and potassium. He found that these ions are in continuous movement across the active surface of the membrane of this single fiber preparation, even in a resting state. Continuing studies are in progress to determine the effects of various states of activity and the effects of radiation.

In other avenues of basic research, radiophosphorus has proved valuable as a label for studying the movement of a number of the bodily processes. Fundamentally, there are two ways by which a compound may be labeled for experimental follow-up. One method is by chemical synthesis, which is often time consuming. A more attractive approach lies in the utilization of plants, animals and various micro-organisms as the synthesizing agents for various sugars, steroids and proteins. A number of sugars have been prepared with a "phosphorus" label and their movement and activity studied in this way.[6] The first experiments which demonstrated in vivo the theories of glycolysis which had developed from in vitro studies were carried out with radiophosphorus.[7] The presence of phosphorus in a variety of bio-

4. Quimby, Edith: Radioactive Sodium as a Tool in Medical Research, Am. J. Roentgenol. **58**:741, 1947.

5. Nachmansohn, D.: Personal communication to the author.

6. Meyerhof, O.; Ohlmeyer, P.; Gentner, W., and Maier-Leibnitz, H.: Studies on the Intermediate Reactions of Glycolysis with the Aid of Radioactive Phosphorus, Biochem. Ztschr. **98**:396, 1938. Wood, H. G.: Tracer Studies on the Intermediary Metabolism of Carbohydrates, in: Isotopes in Biology and Medicine, Madison, Wis., University of Wisconsin Press, 1948.

7. Kalckar, H. M.; Rehlinger, J., and Melder, A. J.: Rejuvenation of Phosphate in Adenine Nucleotides: Rate of Rejuvenation of Labile Phosphate Compounds in Muscle and Liver, J. Biol. Chem. **154**: 275, 1944.

chemical compounds gives its radioisotope widespread use. The presently available isotope of phosphorus is a pure beta emitter with a half-life of fourteen days, which makes it suitable for a number of studies and also as a therapeutic agent.

The universal presence of carbon in organic compounds makes for a wide use of carbon 14 which has a half-life of about five thousand years and emits only beta particles. Because of its long half-life and deposition in bone[8] it is not available for human experimentation.

There has been a great deal of investigation on the applicability of radioactive isotopes as therapeutic agents. At present, radiophosphorus is the most satisfactory agent for the treatment of polycythemia vera. In chronic myeloid leukemia, radiophosphorus has about the same value as roentgen therapy with the advantages of ease of administration and absence of radiation sickness. In chronic lymphoid leukemia most observers feel that radiophosphorus is not as valuable as roentgen therapy.[9] Radiophosphorus may be used as a source of superficial external irradiation for a variety of skin lesions.[10]

Less than one-third of the carcinomas of the thyroid gland will pick up a sufficient amount of radioiodine to produce an adequate dose of radiation. However, the use of various agents, such as thyroid-stimulating hormone, will probably increase the percentage of these tumors that may be successfully treated with radioiodine.[11] Radioiodine when administered to patients with hyperthyroidism will cause a rapid disappearance of the hyperthyroid state. In patients who are poor surgical risks and who have small smooth goiters it may be the treatment of choice.[12]

Radioactive cobalt has many physical characteristics which should make it a satisfactory substitute for radium.[13]

There has been so much said and written regarding the harmful effects of radiation and the dangers that are inherent in the use of radioactive materials that a word here would seem advisable. In general, it may be said that there are three types of radioactive emanation which are in biological and medical research significant. Alpha particles are highly damaging but easily filtered; hence unless they are inhaled or ingested or penetrate through the broken skin they are not significant. Radioactive isotopes emitting alpha particles are not generally used in broad research programs. Beta particles are moderately damaging and superficially penetrating. It is possible to shield against beta particles by simple devices. Gamma rays, which are quite similar to roentgen rays, are the least damaging of the three but are highly penetrating. Accordingly, definite precautions must be used in handling these materials which emit gamma radiations. Distance is still the best protection from these rays, and attention must be given to properly protected storage facilities. Personnel working with radioactive materials must be supervised so that the amount of radiation which they receive is within the tolerance level, which is presently fixed at 0.1 r a day. A piece of dental film worn in a container known

8. Bloom, W.; Curtis, H. J., and McLean, F. C.: The Deposition of C14 in Bone, Science **105**: 45, 1947.

9. Reinhard, E. H.: Artificially Prepared Radioactive Isotopes as a Means of Administering Radiation Therapy, Am. J. Roentgenol. **58**:773, 1947. Brues, A. M., and Jacobson, L. O.: Comparative Therapeutic Effects of Radioactive and Chemical Agents in Neoplastic Diseases of the Hematopoietic System, ibid. **58**:774, 1947.

10. Low-Beer, B. V. A.: External Therapeutic Use of Radioactive Phosphorus: I. Erythema Studies, Radiology **47**:213, 1946; Radioactive Phosphorus as an External Therapeutic Agent in Basal Cell Carcinoma, Warts and Hemangioma, Am. J. Roentgenol. **58**:1, 1947.

11. Keston, A. S.; Ball, B. P.; Frantz, V. K., and Palmer, W. W.: Storage of Radioactive Iodine in a Metastasis from Thyroid Carcinoma, Science **95**:362, 1942. Marinelli, L. D.: Adenocarcinoma of the Thyroid with Hyperthyroidism and Functional Metastasis: I. Studies with Thiouracil and Radioiodine, J. Clin. Endocrinol. **6**:247, 1946.

12. Chapman, E. M., and Evans, R. D.: The Treatment of Hyperthyroidism with Radioactive Iodine, J. A. M. A. **131**:86, 1946.

13. Myers, W. G.: Radioactive Needles Containing Cobalt 60, Science **107**:621, 1948.

as a film badge and after development compared with exposed control films affords a simple means of measurement. Pocket electroscopes are also a useful monitor, and a distinct advantage is the fact that at any particular time a measure may be obtained of the amount of the radiation entering the body.[14]

The semiannual report of the Atomic Energy Commission to Congress was devoted in large measure to a presentation of the applications of radioisotopes. Reports from the diverse research projects in which these substances are being used emphasize repeatedly their value in basic and applied research.

Discussion

Mr. Howard A. Carter (Chicago): The release of energy within the atom is undoubtedly greatest achievement of science and technology in modern times. Without belittling this achievement, it is relevant to point out that we have a source of energy all about us which so outshines the atomic bomb that its energy dwindles to insignificance. I refer to the sun.

The radiation from the sun, if harnessed efficiently, would operate our automobiles, heat our homes and run our factories. It is calculated that the solar energy reaching the earth's surface is equal to 4,690,000 horsepower per square mile. Thus, the amount of energy absorbed on the black top of an automobile, if captured and converted into mechanical energy, would be sufficient to move the car, although not very fast (about ½ horsepower). The radiant energy of the sun beating down on the roof of a house is equivalent to several dollars' worth of coal per day.

In pointing out the tremendous energy of the sun, I do not intend to overemphasize the therapeutic value of its rays. Yet, it is well known that ultraviolet, visible and infra-red radiations are being used effectively in the treatment of disease — ultraviolet rays for rickets and a limited number of skin ailments and infra-red radiation for relief of muscular disorders.

Since the sun is responsible in no small way for storing up of energy in fuels from the earth, one cannot help but look forward with enthusiasm to research on the theory of chlorophyll. Isotopes will aid in this research.

Probably because of restrictions, the writer of the article under discussion has been obliged to hold himself in check and has not given us the benefit of all that is known about the therapeutic use of radioactive compounds. It is to be hoped that in the near future, the threat of using atomic energy for destroying life will be no more and that the new found tool may be used extensively for the benefit of mankind.

Dr. H. T. Zankel (Cleveland): Is there any isotope that has a half-life of five minutes or so that we can use?

Mr. Howard A. Carter (Chicago): I should like to ask where one could go to get information regarding courses for physicians on radioactive isotopes and their use for biologic purposes?

Dr. Bowers (closing): In answer to the first question: yes, there are. I do not recall which ones. The information is not restricted, but I simply do not remember them. Such a half-life would preclude the use of the radioactive isotope in any biologic or medical research, unless you were living right next to a chain reaction pile. In general, the isotopes which are used in research have half-lives which, I would say, roughly, range from twenty-four hours to twelve days.

In regard to the educational opportunities for physicians, the Atomic Energy Commission has been increasingly conscious of the desirability of such an arrangement, and we have established, through the Oak Ridge Institute of Nuclear Studies at Oak Ridge, Tenn., continuing instruction courses, which are of one month's duration and which are designed to train physicians in the technics which are necessary for the handling of radioactive isotopes. Further information regarding these courses may be obtained from Dr. William Pollard, at Oak Ridge.

Secondly, we have initiated a broad medical fellowship program through the National Research Council, through which physicians may obtain two years of training in this field.

Finally, at the regional laboratories men may obtain appointments for anywhere from six months to two years for work in training.

14. Sullivan, W. H.: Control of Radioactivity Hazards, Chem. Engineering News 25:1862, 1947.

THE COORDINATING COUNCIL FOR CEREBRAL PALSY IN NEW YORK CITY *

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The problems which present themselves when a child is or becomes handicapped are not only those personal to the child himself. The total economy and organization of the child's family are influenced. Changes in the conduct of the home involve adaptations by other members of the family to their working and social relationships with the community in which they live and move. The community in a democratic state, in turn, accepts certain responsibilities in such situations and attempts to supply certain needs and services otherwise unavailable. This is true for every handicapped child.

The child falling in the group which we have learned to include in the term "cerebral palsy" presents problems of a particular nature, many of which go far and beyond those common to other orthopedically handicapped children. The very nature of cerebral palsy makes it imperative that these children be considered separately from other crippled children, and that complete comprehensive care be provided for them. Experience has shown that the child with cerebral palsy is neglected when he is grouped with other crippled children, and often he is resented and ridiculed by those children. Comprehensive care, including general pediatrics, correction of associated medical conditions, psychiatry, education and prevocational training, all correlated with intensive physical and occupational therapy, is essential if these children are to be brought to a level where they can compete with the normal population. There is no absolute cure for cerebral palsy. It is only by making the best use of the facilities which are present and directing them to compensate for the child's handicaps, that these patients can be habilitated. For years individuals and agencies, public and private, have attempted to do something, but never have the total needs been adequately met. Nothing short of a concerted community attack could hope to integrate the many facets presented by the problem.

A very small number of these children from the wealthiest families attend special private schools. Another relatively small number are objects of experimental groups here and there throughout the country. A large number are treated at cerebral palsy clinics in various hospitals. These clinics are generally overcrowded and unable to treat the individual child as frequently as necessary, do not attempt to meet the educational needs of the children and are often difficult of access because of transportation. Many children receive inadequate home treatment. A large number of the patients are not treated at all because of inadequacy or unavailability of facilities and a lack of understanding or apathy of the parents.

It has been estimated that there are 96 educable, trainable patients with cerebral palsy up to the age of 16 years in every 100,000 population. Projecting these figures on New York City, with a population of over 7,000,000 persons, it is probable that we have in our metropolis at least 7,500 children falling in this category. The exact figures are not attainable, and they will not be available until cerebral palsy is included in the list of compulsory

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reportable diseases. This is important for other than the usual urge for reporting contagion. It will be impossible to plan to provide for the care of these patients until we can estimate with some degree of accuracy the extent and cost of so doing. All local health departments should make compulsory the reporting of cases of cerebral palsy.

The great need for coordinated effort on behalf of persons affected with cerebral palsy in New York City led to the institution of the Coordinating Council for Cerebral Palsy. At the time of its organization many professional and nonprofessional agencies existed in Greater New York which were attempting by individual efforts to improve the situation of persons with cerebral palsy. Considerable unification among lay groups had been achieved through the establishment of the New York State Association for Cerebral Palsy, with its chapters in various cities and communities throughout the state. The appointment of a Joint Legislative Committee on Cerebral Palsy, representing both the Senate and the Assembly of New York State, had instituted legislative study of the problem. But the need for further study and coordination of efforts still remained, in order to find an adequate solution to the manifold problems of cerebral palsy in the City of New York.

Since the human spirit always seeks to find a solution to its problems, and since none was forthcoming from the public authorities in this instance, it was only natural that these distressed persons should seek each other out, and band together to work in behalf of their common interest. This gave rise to a number of organized groups of lay persons, each with its own program. There was a very real danger that they might impede each other and fail to agree on a program which would offer the best solution. On the other hand, the public authorities as represented by the Division for Physically Handicapped Children of the Department of Health and of the Board of Education, were each aware of the problems, and were seeking to develop programs that would serve the best interests, and command public support. There was also a conviction among the physicians that the body of knowledge concerning cerebral palsy was still limited and that there was a great need for research to expand its boundaries, and make possible further progress in treatment.

A situation therefore existed which demanded not only coordination but also leadership, and these needs gave rise to the organization of the Coordinating Council. At a conference between various leaders of the lay groups and physicians who also recognized the importance of the problem, it was concluded that there was a need for a central coordinating group whose membership would be composed largely of physicians. In order to place this body on a level that would command the greatest respect, it was agreed that it should be made representative of the five medical schools and that the Dean of each school should be asked to appoint two members. These appointees together with the official representatives of the Department of Health and the Board of Education, two organizing members (physicians from the Hospital for Special Surgery which maintained a large cerebral palsy clinic), and one lay member, who was retained as Acting Treasurer, composed the original membership of the Council.[1]

On Jan. 16, 1947 the group had its first meeting. Meetings were held monthly thereafter. At these meetings, anything and everything relative to the total problems of cerebral palsy were discussed. Various agencies were invited to send representatives and discuss problems with the Council. Home nursing services, welfare agencies, parents associations in turn met with the council. As one, these agencies encouraged the work of the Council and expressed gratitude that such a representative group could be made available to integrate treatment, education, service and research.

The deliberations of the Council finally brought forward the aims and purposes of the Coordinating Council.[2] Stated succinctly these are:

1. Constitution and By-Laws, Coordinating Council for Cerebral Palsy in New York City, extract from Preamble.
2. Constitution and By-Laws, Coordinating Council for Cerebral Palsy in New York City, extract from Article I.

1. To further the development of adequate programs for the treatment, education and adjustment of persons with cerebral palsy.
2. To stimulate research in the problems of cerebral palsy.
3. To promote the training of adequate personnel for the care of persons with cerebral palsy.
4. To coordinate all efforts, private and public, to meet the problems of persons with cerebral palsy.
5. To serve in advisory capacity and standards for clinics, schools and personnel for the care of cerebral palsy patients in the metropolitan area.

A joint meeting of the Coordinating Council for Cerebral Palsy and the Orthopedic Advisory Committee of the Departments of Health and Education, and representatives of the "Legislative Committee to Study the Problems of Cerebral Palsy" was held Oct. 2, 1947, to discuss the subject further. At this meeting a subcommittee from the joint membership was formed to formulate standards for hospitals, clinics and schools caring for persons with cerebral palsy. The preliminary report was presented and accepted at a subsequent meeting of the Coordinating Council on Nov. 25, 1947. This report is appended in full.

A constitution and by-laws were drawn up and accepted; nomination and election of officers took place on May 27, 1948, and permanent organization of the Council was effected at that time.

Present membership is limited to appointed representatives of institutions and agencies within the Greater City of New York who are concerned with the problems of cerebral palsy, specifically:

1. Representative of the New York City Department of Health, Division for Physically Handicapped Children.
2. Representative of the New York City Board of Education, Division of Child Welfare.
3. Appointed representative of the New York Academy of Medicine.
4. Appointed representatives (2 each) from each of the five medical colleges in New York City:
   Cornell University Medical College.
   College of Physicians and Surgeons, Columbia University.
   New York University College of Medicine.
   New York Medical College.
   Long Island College of Medicine.
5. Representatives of hospitals in which programs for cerebral palsy are in operation.
6. Two lay members interested in furthering planning of cerebral palsy programs, including an elected member to represent the Cerebral Palsy Association of New York City.
7. Representatives of other agencies actively working with cerebral palsy patients may be added at the discretion of the Executive Committee.[3]

Admission to membership shall be by invitation and candidates shall become members upon affirmative vote of a majority of the members of the Executive Committee, at a regular or a special meeting.[4]

A subcommittee on research has been appointed carefully to analyze, select and coordinate research problems as submitted to the Council. Funds have been made available by organizations and interested individuals to support worthy research. To date, numerous requests for aid in research have been submitted. The Coordinating Council has already acted favorably on three such projects and funds have been provided to carry them forward:

1. Studies in the Use of Vital Stains in Cerebral Lesions.
2. Disturbances in Perception in Children with Cerebral Palsy.
3. A Study of the Mental Organization of the Cerebral Palsied Child.[5]

3. Constitution and By-Laws, Coordinating Council for Cerebral Palsy in New York City, Article II, Section I.
4. Constitution and By-Laws, Coordinating Council for Cerebral Palsy in New York City, Article II, Section II.
5. Coordinating Council for Cerebral Palsy, minutes of meeting of March 25, 1948.

The Coordinating Council of Cerebral Palsy is now being incorporated to permit greater effectiveness in its work.

As a member of the Council and one who has been active throughout its deliberations, I wish to say that it is inspiring to work with such a group, devoting unselfishly of their time, for the promotion of so worthy a cause. The cooperation we have received from all the groups — parents, educational, health, social, medical and service affiliations — has been genuine and enthusiastic.

This is the first report of the activities of the Coordinating Council for Cerebral Palsy in New York City. Our work has only begun, but good and substantial headway has been made in the short period the organization has existed. The problem of cerebral palsy is nationwide and at present much in the public eye. We tender this report at this time as a stimulus to similar efforts in other communities.

ADDENDUM

SUBCOMMITTEE ON STANDARDS

Date: Nov. 25, 1947
Present: Dr. Leo Mayer, Chairman
Dr. William Cooper
Dr. Eva Landsberg
Dr. Frank J. O'Brien
Dr. William B. Snow
Absent: Dr. Stanley S. Lamm

The subcommittee agreed that recommendations on standards for the operation of cerebral palsy clinics should be brief and flexible enough so as to allow each clinic facility to develop a character of its own. Although involved standards for cerebral palsy clinics, complete in every detail, cannot be established, there are several considerations as to services, staff and physical organization that can be set forth:

Personnel in Hospital Clinic

Well trained and experienced workers in this field are very scarce. It is felt, however, that an extensive special training need not be an absolute prerequisite for therapists, social workers and other personnel, with the exception of the physician in charge. There are many workers who have a real aptitude in this field and could be quickly trained on the job under good guidance. It is felt that a basic training course could be given to therapists, social workers and other persons in order to equip them for a place in the program. A six weeks' concentrated course including didactic lectures and supervised work in already operating clinics would equip a capable person to begin work in a clinic.

Physician in charge of clinic might be a pediatrician, neurologist, specialist in physical medicine or rehabilitation. He should have a strong interest in and broad knowledge of the problem.

Consultation facilities in various medical specialties should be available, including orthopedic, physical medicine, pediatric, neurological, eye, ear, dental and psychiatric.

Physical therapists. A therapist can handle approximately 8 to 10 patients a day. Physical therapists, in addition to their regular training, should have at least six weeks' special training at an established cerebral palsy clinic.

Occupational Therapists. The number of occupational therapists required would be approximately one-half the number of physical therapists and would depend upon the demand of the clinic.

Speech therapists should have a suitable training in speech pathology. The number of speech therapists would be dependent upon the number of children requiring training and would be approximately one-half the number of physical therapists.

Medical social workers in addition to a standard preparation in medical social work, should also participate in the cerebral palsy training program.

Psychologist should be employed on a consultation basis. The psychologist should be familiar with the special limitations of children with cerebral palsy.

Secretary to interview patients and compile a medical record.

Stenographer.

(*Continued on page 413*)

ARCHIVES of PHYSICAL MEDICINE

OFFICIAL PUBLICATION AMERICAN CONGRESS OF PHYSICAL MEDICINE

.·. EDITORIALS .·.

JAMES CLAUDE ELSOM

Dr. James C. Elsom, 83, Past-President and member of the Executive Council of the American Congress of Physical Medicine died in Milwaukee of a heart attack on April 11, 1949.

In 1936, Dr. Elsom retired from active association with the University of Wisconsin, an association which had been continuous since 1894. During his affiliation with the University, he served as Professor of Physical Education, Medical Examiner, Professor of Physical Therapy and Director of Physical Therapy at the University of Wisconsin General Hospital, Madison.

Dr. Elsom was born in Nelson County, Virginia on May 16, 1866. He received his education from Norwood College, Virginia and Medical College of Virginia, receiving his M.D. in 1886. He was Physical Director of the Young Men's Christian Association in Galveston, Texas from 1889-1891 and held the same position in Minneapolis from 1892-1894, at which time he joined the faculty of the University of Wisconsin. In World War I, Dr. Elsom served as Captain in the U. S. Medical Corps. He was a frequent contributor to periodicals in the fields of medicine and physical education and in 1929, published the book "Community Recreation."

The officers and members of the American Congress of Physical Medicine extend their sympathy to his family.

INSTRUCTION COURSES

In the past there have been many instruction courses, held at the Congress and elsewhere, in physical medicine and physical therapy. Before the field of physical medicine developed into a full-fledged specialty, these courses were designed for the physician who had an interest in physical medicine and who wished to learn more relative to the indications and procedures used, and to assist in further training of technicians. In most instances, these physicians did not consider themselves specialists. At that time, many of the physical therapy technicians were more aware of the technics used than were some of the physicians. Even at present, many technicians are asked to use their own judgment in the treatment of patients by physical procedures. Because of the interest of the technician in instruction, the scarcity of physicians who practice physical medicine as a specialty, and the tendency on the part of the physician to delegate most of the practice of physical medicine to the judgment of the technician, instruction courses have been poorly attended by physicians and well attended by technicians. This has made it somewhat difficult to organize courses on a level which is commensurate with the education and professional training of both groups. The tendency has been to organize the courses on a level which would be of interest to the technician, rather than to the physician.

In recent years, because of the increased interest in specialization and the rather extensive research being done in the field, instruction courses, organized for the purpose of teaching the physician the use of physical medicine in a more or less elementary manner, have become unsatisfactory for many young physicians. Many of these young men are attempting to specialize in physical medicine and are looking forward to the time when they might take the examination to become diplomates of the American Board of Physical Medicine. They will have had formal training, perhaps residencies, or considerable experience in the practice of physical medicine. Therefore, they are interested in more advanced instruction than would be the physician who is interested in the field to the extent that he might use certain procedures indicated in another specialty, or in general practice, or that he might have sufficient knowledge to know when to refer a patient to a physiatrist.

As the field has become more developed, the rationale and the scientific basic principles for the use of physical procedures are more evident. It is obvious that a wide basic knowledge relative to the field is necessary to practice, to do research, and to keep up to date in the field. The knowledge necessary to practice physical medicine adequately has evolved into that which is on a level with any other specialty. This being the case, the subject matter presented in some of the courses of instruction should consist of that which would be of particular interest to the physician according to his educational background, whether it be for the young man beginning to specialize, the general practitioner or the physiatrist.

It is for these reasons that the instruction courses given during the meeting of the Congress have been changed. After several years of experience in organizing these courses, the Committee on Education believed that two courses should be made available. One course is for physicians who are not specialists, but interested generally. The subjects chosen for this course are to be those of a clinical nature, the presentation to be somewhat broad, and of practical value. Also, the courses are to be on a level at which technicians could obtain considerable assistance, if they wish to attend. The second group of subjects to be presented are those in which the physicians especially interested in physical medicine, or physicians preparing for the specialty Board, would be particularly interested. The subjects presented will be mainly in the basic sciences and research developments as related to physical medicine. The number of subjects is limited, but several hours may be devoted to one subject, such as certain phases of physiology or anatomy. This gives the instructors an opportunity to cover more specific material and bring the subject matter up to date for the physician particularly interested in the field, and gives a good review of those who may be preparing for Board examinations.

The criticism in the past relative to the courses at the Congress was that the material was too elementary, and that the instructor had to cover too broad a subject to do more than deal with generalities. In limiting the number of subjects given each year, some of these difficulties may be overcome. It is the desire of the Committee on Education to limit the subjects each year in order to cover the material adequately, to obtain speakers who are outstanding authorities in each field, and to repeat the subjects every three to five years in both courses. By doing this, the subjects presented can be kept up to date, and rather extensive courses in a given subject—basic, research or clinical—can be presented.

The possibility of presenting only one group of subjects was considered,

and has been done in the past, but there is considerable variance of interest among the members of the Congress and others interested in physical medicine. Therefore, the presentation of the two courses, one primarily clinical and the other primarily on basic principles and research, seemed more adequate. It allows a choice of either for those taking the course and, whereas all twenty lectures could not be covered in one year, by repeating them over a period of years, any one individual could attend all of the presentations.

The instruction course of the Congress is in no way to replace the scientific session.

There are a number of medical centers, over the country, which have made very earnest attempts to conduct instruction courses in physical medicine. These courses have been designed to attract physicians primarily. However, even in many of these, there has been a tendency for the courses to be poorly attended by the physicians, and well attended by technical personnel. This undoubtedly is largely the fault of physicians, who tend to send their technical assistants, because they do not realize the need for them to know more concerning the field than do the technical aides. In addition, it saves time for them to send technicians, rather than to go themselves. By doing this, the physicians are only fostering the already too great tendency to make the technician use medical judgment in the treatment of patients.

In addition to this, and perhaps of greater importance, is the fact that the field of physical medicine cannot be placed on a completely scientific footing until the physician becomes fully cognizant of the fact that an educational background in medicine is necessary to grasp the full importance of its use. It is no more logical to assume that the medical aspects of physical medicine can be learned and carried on adequately by having the physical therapy technician keep up with advances in the field by attending instruction courses, than it would be for the roentgenologist to send his technical aides to such courses and expect to remain in touch with the field of roentgenology. This does not mean that the physical therapy technician is not an important person in the practice of this branch of medicine. She should be instructed likewise, but on her level; she should not be expected to be an authority on the whole field.

The physician is more likely to consider instruction courses more important to him, or more nearly on his level, if the subjects deal with clinical aspects and if the courses are conducted for physicians only. It has been shown in a few instances that where the combined courses (for physical therapy technicians and physicians) were poorly attended by physicians, when the courses were changed to those for physicians only they were relatively better attended by medical men.

In view of some of the difficulties mentioned, it might be well to consider having yearly courses conducted in different parts of the country, and that these courses be divided into those designed for the physiatrist, for the general practitioner, and for the technician, rather than trying to conduct one general course to attract all groups.

MEDICAL NEWS

Dr. Kovacs Speaks

Dr. Richard Kovacs spoke on the "Uses and Abuses of Physical Therapy in Industrial Medicine and Surgery" at the annual convention of the Medical Society of the State of New York, held in Buffalo, May 2 to 5, 1949. His paper was in the Section on Industrial Medical and Surgery.

Dr. Boynton Promoted

Dr. Ben L. Boynton has recently been made professor of physical medicine, Baylor University College of Medicine, Dallas.

Physical Medicine Appointment

Dr. Isadore Levin has been appointed associate professor of medicine, in charge of the department of physical medicine on the faculty of Georgetown University School of Medicine, Washington. Dr. Levin was in the United States Public Health Service from 1931 through 1933, and was in general practice from 1933 to 1936 in this city. He has been specializing in physical medicine since 1936 and has been director of the physical medicine department at Doctors Hospital since its opening in 1940.

Offices of Baruch Committee on Physical Medicine Moved

As of May 1, 1949, the offices of the Baruch Committee on Physical Medicine have been moved to 30 North Michigan Avenue, Chicago 2.

D. T. Watson School Changes Name

The name of the D. T. Watson School of Physiotherapy has been changed to the D. T. Watson School of Physiatrics, and training in physical medicine is now offered to physicians as well as to physical therapists.

Medical Periodicals Wanted

The National Committee for Chile is now receiving gifts for the library of the Medical School of the University of Chile at its new Collection Center in the Library of Congress, Washington. The newer materials in the library, including periodicals, books and reference materials, were totally destroyed in the recent fire. Medical periodicals of the last ten years and recent medical books are urgently needed. Contributions should be sent to the Committee, Room 318, Library of Congress, Washington, D. C.

Session on Physical Medicine Medical Society of the State of New York

A symposium on "Rehabilitation" was presented in the session on Physical Medicine during the 1949 annual convention of the Medical Society of the State of New York, held May 2 to 6, in Buffalo, New York. The speakers and their subjects were: "Rehabilitation of the Paraplegic in the Veterans Administration," Harry Kessler, M.D., and Arthur S. Abramson, M.D.; "Rehabilitation in Hemiplegia by the Private Physician," Donald A. Covalt, M.D., and "Returning the Patient to Normal Activity Following Injury" by R. Plato Schwartz, M.D.

Association for Physical and Mental Rehabilitation

The annual session of the Association for Physical and Mental Rehabilitation was held May 18 to 21, 1949, at the Hotel New Yorker, New York, N. Y. Among the speakers were:

Richard Kovács, New York, Evolution of Physical Medicine Rehabilitation.
A. B. C. Knudson, M.D., The Role of Corrective Therapy in Physical Medicine Rehabilitation.
Howard A. Rusk, M.D., Rehabilitation, Its Place in Medical Care.
Hans Kraus, M.D., Therapeutic Exercises in Rehabilitation.
Jack Lovelock, M.D., Rehabilitation in Poliomyelitis.
Donald A. Covalt, M.D., Development of Physical Medicine Rehabilitation in Civilian Hospitals.
Otto Eisert, M.D., Rehabilitation of the Chronic Medically ill.
H. Harrison Clarke, Ph.D., Further Development of Objective Orthopedic Strength Tests.
Sidney Licht, M.D., The History of Medical Gymnastics.
Josephine Rathbone, Ph.D., The Group Approach to Technics in Relaxation.
Arthur S. Abramson, M.D., Exercises for Paraplegics.
Louis B. Newman, M.D., Fundamentals in Evaluating Disabilities.
Karl Harpuder, M.D., Vascular Adjustments in Exercise.
Eugene J. Taylor, Social and Economic Implications of an Aging Population.

National Foundation for Cerebral Palsy

At the first national public conference in New York on cerebral palsy the formation of the National Foundation for Cerebral Palsy was announced by Leonard Goldenson, president. The foundation will serve as "a clearing house of information, a coordinating agency and driving force" for cerebral palsy organizations throughout the country. Other officers of the foundation were listed as Mr. Arthur Larschan, New York, and Mr. Albert Felmet, Jr., president of the New York State Cerebral Palsy Association, which sponsored the conference, and Mrs. James Killilea of Rye, chairman of the board. Mr. Larschan and Mrs. Killilea are vice-presidents of the state organization. They and Dr. Foster Kennedy, chief of neurology at Bellevue Hospital, were the incorporators.

Open New Laboratory

The University of Illinois' new $400,000 Aero Medical and Physical Environment Laboratory, planned to study the effect of physical environment in health and disease, has been opened. Dr. Andrew C. Ivy, vice-president of the University of Illinois in charge of the Chicago Professional Colleges, will serve as director. The staff is headed by Dr. John P. Marbarger, research director; Victor Guillemin, Jr., Ph.D., biophysicist, and Maurice K. Fahnestock, M.S., engineering director. The research studies are expected to contribute to basic physiologic knowledge concerning the effect of physical environmental factors on healthy and diseased human beings. The studies also are designed to improve therapeutic procedures in the treatment of certain types of disease and to supplement present knowledge in the field of aviation medicine. Major installations planned for the future include a radiation test laboratory, a constant temperature, humidity and pressure room and a noise and vibration-free room.

Short Courses in the Diagnosis and Treatment of Poliomyelitis Patients for Physicians

Scheduled during 1949
(as of May 1, 1949)

Training Center	Scheduled Courses	For Detailed Information and for enrollment write to:
Children's Hospital Boston, Massachusetts	June 13-17 Aug. 15-19	William T. Green, M.D.
City Hospital Cleveland, Ohio	July 18-23 Aug. 8-13 Aug. 29-Sept. 3	John A. Toomey, M.D. Dept. of Contagious Diseases
D. T. Watson School of Physiatrics Leetsdale, Pennsylvania	1-3 weeks, depending on need of each individual. Dates to be specially arranged. Emphasis on when to prescribe the respirator and when the rocking bed, with variations to meet the needs of each patient.	Jessie Wright, M.D. Medical Director
Georgia Warm Springs Foundation Warm Springs, Georgia	3-6 months, starting July 5, and October 3.	Robert L. Bennett, M.D. Director of Physical Medicine
Stanford University School of Medicine San Francisco, Calif.	3 days—probably the second week in July.	W. H. Northway, M.D. Assistant Dean
University of Colorado Medical Center Denver, Colorado	Nov. 23-28 Nov. 14-19	Winona C. Campbell, M.D. Director of Poliomyelitis Teaching Program

The Coordinating Council for Cerebral Palsy in New York City

(*Continued from page 408*)

Space Requirements

In general, a minimum of four rooms or areas would be required — one for each of the therapies and a fourth which might be employed as an office for interviews. One of the rooms should be large enough to be used for group conferences and lectures. Facilities for examining patients should be provided in one of the rooms, possibly in the form of an ante-room.

It is planned to discuss further the question of personnel and training. The question of actual operation of the clinic — equipment, records, conferences, etc. — has still to be gone into.

Preliminary Comments on School Clinics

The nucleus of a training program for cerebral palsied children is essentially educational. Classes should be established in public school buildings headed by a teacher in charge. Since the educational program for cerebral palsied children emanates largely from the medical situation, the school project should be supervised by a physician. This doctor in charge would, logically, be the head of the cerebral palsy clinic in a hospital associated with the school unit. He would visit the school approximately once a week or as often as necessary and make periodic examinations and indications for training. Facilities for treatment would be established in the schools, and the children would receive physical therapy, occupational therapy and speech therapy in the school environment. The hospital with which the school is connected would serve as an adjunct to it and would supply treatment which could not be provided in the school itself. The treatment load of cerebral palsy clinics in hospitals would thus be reduced and a tremendous saving in time for parents, children and staff would be effected.

BOOK REVIEWS

THE MACHINERY OF THE BODY. By *Anton J. Carlson* and *Victor Johnson*. Third edition. Cloth. Price, $4.50. Pp. 639, with 220 illustrations. University of Chicago Press, 5750 Ellis Ave., Chicago 37, 1948.

This is the third edition of the most useful textbook on the basic principles of physiology for students with a minimal scientific background. The basic text is essentially the same as in the previous edition, and to it the authors have added some of the more important advances in the sciences of medicine and physiology, including the newer knowledge of blood transfusion and the use of blood banks, of nutrition and vitamins, of the employment of radioactive elements in biologic research, and of the use of sulfa compounds and penicillin. Suitable illustrations have been added, and many minor changes in phraseology have been made.

This book is highly recommended as a suitable text to elementary physiology.

PERIPHERAL VASCULAR DISEASES. By *David W. Kramer*, M.D., F.A.C.P., Associate Professor of Medicine, Jefferson Medical College; Assistant Physician, Jefferson Hospital; Chief Clinical Assistant, Vascular Clinic, Jefferson Hospital; Visiting Physician, Medical Division, Philadelphia General Hospital; Consultant on Peripheral Vascular Disorders, Philadelphia General Hospital; Attending Physician, Metabolic Division and Chief of Diabetic Clinic, Jewish Hospital; Attending Physician and in Charge of Metabolic and Peripheral Vascular Disorders, St. Luke's and Children's Medical Center; Metabolist to Eagleville Sanatorium. Foreword by Edward L. Bortz, M.D. Fabrikoid. Price, $8.00. Pp. 620 with 157 illustrations. F. A. Davis Co., 1914 Cherry St., Philadelphia 3, 1948.

The book is divided into five parts, part I, symptoms, signs and test. In this section all the various tests are included that have been employed with an explanation of their rationale and an evaluation of their usefulness. The author concludes that the following have been most helpful to him: oscillometer, histamine test, thermometric studies, x-ray arteriography on selected cases and observations on venous filling time and tests for plantar ischemia. Part II — The occlusive vascular disorders; here the usual forms, such as thromboangiitis obliterans, periarteritis nodosa, acute, subacute and chronic arteritis are considered. A chapter is devoted to the treatment of thromboangiitis obliterans in which the various types of physical measures are briefly discussed. A suggestion for the local use of ultraviolet ray therapy shows a lack of understanding of the modality. The recommendation for the positive negative apparatus because of a belief that there is "improvement of circulation, development of a new blood supply and assisting the circulation of blood to distal parts" has not been the consensus of opinion of most clinics, and comments on diathermy and infra-red rays fail to show how they may be employed to their best advantage. The other forms of treatment such as medications, intravenous therapy and surgery are commented on. Part III — Vasospastic, vasodilator, and unclassified groups: This grouping consists of the functional disorders, scleroderma and Raynaud's diseases, and also such local conditions as mechanical irritation due to cervical rib, transverse spinous process and anterior scalenus syndrome. Certain occupational disturbances are discussed in the vasospastic disorders. Part IV — Gangrene and leg ulcers: All the various causes for these conditions are very briefly considered. There is a repetition of the conditions found in the earlier chapters plus numerous other disorders. This section is sketchy. Part V — Veins, anticoagulants, antibiotics and lymphedema: The author has covered the subject completely and has included all the modern forms of treatment and diagnostic procedures. The tendency to recommend too many types of therapy with equal favor might be confusing to students and general practitioners. Dr. Kramer is one of the outstanding authorities on peripheral vascular disease and his experience and knowledge of these disorders entitle him to write in a more dogmatic manner.

The illustrations are numerous but in many instances are poorly reproduced. The photographs of leg ulcers or amputations for the many diseases are repetitous without in the least showing any characteristic features. A more generous use of colored plates (only two are included) with a more judicious selection of the black and white illustrations would be an improvement.

FUNCTIONAL NEURO-ANATOMY. By *A. R. Buchanan*, M.D., Professor of Anatomy, University of Colorado School of Medicine, Denver. Fabrikoid. Price, $8.50. Pp. 242, with 199 illustrations. Lea & Febiger, 600 S. Washington Square, Philadelphia 6, 1948.

This volume is the result of fifteen years work by the author so to present this subject so that it does not remain a deep and unsolved mystery to the student until the final lectures of the course are given. This is indeed a worthy cause and the writer has not only accomplished his task but has done it well. The reviewer wishes that such a text had been available when he studied the subject. A strictly functional approach has been made so that the students' interest and un-

derstanding of the subject matter is never lost. Another excellent innovation is that clinical applications of neuroanatomy are fully discussed within the body of the text. The clinical significance of what is being studied therefore is impressed on the student from the very first. The subject matter is ably presented and, as the author states, the text is not intended to be an exhaustive presentation of the subject but is rather designed to present the subject in as simple and direct a manner as conducive to the rapid assimilation of a working knowledge of the nervous system. The figures representing cross-sections of the nervous system are based upon tracings of actual sections prepared in the author's department. The illustrations used are excellent and well chosen.

This book is highly recommended to students and to those physicians who want to have a good reference in their library. Physiatrists should find this volume of particular interest.

THE WORLD WITHIN. Edited by *Mary Louise Aswell*, with an introduction and notes by Frederic Wertham, M.D. Cloth. Pp. 376. Price, $3.75. Whittlesey House. McGraw-Hill Book Company, 330 West 42nd Street, New York 18, 1947.

In view of the popularity of "psychiatric" novels this collection of stories taken from the classics as well as from contemporary literature should have considerable appeal to lay readers as well as to those professionally interested in mental disease. Each story is prefaced by a brief biographical note and followed by an analysis of the psychiatric content. This is very intriguing reading by itself, and with the comments especially provocative to the student of psychodynamics.

FOUNDATIONS OF PSYCHOLOGY. Edited by *Edwin Garrigues Boring, Herbert Sidney Langfeld* and *Harry Porter*. Weld. Cloth. Price, $4.00. Pp. 632, with 248 illustrations. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16; Chapman & Hall, Ltd., 37-39 Essex Street, Strand, London, W.C. 2, 1948.

This is the sixth printing of the original work which bears a copyright date of 1935. The chapters are written by nineteen contributors who are specialists in their respective fields such as Boring on Intensity, Dallenbach on Somesthesis, Wever on Audition, Longfeld on Action and others.

TREATMENT BY MANIPULATION IN GENERAL AND CONSULTING PRACTICE. By *A. G. Timbrell Fisher*, M.C., M.B., Ch.B. Fifth edition of "Manipulative Surgery." Cloth. Price, $5.00. Pp. 275, with 126 illustrations. Paul B. Hoeber, Inc., Medical Book Department of Harper & Brothers, 49 E. 33rd St., New York 16, 1948.

That this excellent work is in its fifth edition is proof of its value. Unfortunately there are too few references or books available for consultation on this important field of therapy and this new edition should prove to be most welcome. The objective of the author is to draw attention to the great importance and value of manipulative treatment in the treatment, in carefully selected cases, of certain of the sequelae of injuries and diseases particularly affecting the joints, muscles, tendons and fasciae. Much new material has been added, including 45 additional illustrations. Many sections have been rewritten and expanded in an attempt to incorporate recent advances, particularly in the treatment of cuppling deformities of rheumatic disease. It is to be regretted that so little training is given in this form of treatment to students in medical schools. It is too true that this type of treatment has often fallen into ill repute because of abuses by either non-medical practitioners or by unqualified individuals. However, here is a book well written, and well illustrated so that with study a physician should be capable of becoming quite competent. There is a short but excellent historical introduction. Chapter 2 deals with pathology; chapter 3, the prevention of adhesions; chapter 4, the diagnosis of adhesions; chapter 5, the general principles of manipulative treatment. There is a splendid chapter on the dangers of manipulation in unsuitable cases and a chapter on the cult of osteopathy.

Every physiatrist should certainly have this volume in his library for it is a most valuable work for those working in the field of physical medicine. The book is highly recommended to the entire medical profession.

HISTOPATHOLOGY OF IRRADIATION FROM EXTERNAL AND INTERNAL SOURCES. Edited by *William Bloom*, M.D. Contributing authors: William Bloom, M.D.; Margaret A. Bloom, M.D.; Peter Paul Henry De Bruyan, M.D.; Minnie Heller, B.S.; Marjorie Ismond; Raymond G. Murray, Ph.D.; Mila Pierce, M.D.; Ruth P. Rhoades, M.A.; Ray S. Snider, Ph.D.; George Svihla, M.S.; Ella Tyree, B.S. National Nuclear Energy Series, Manhattan Project Technical Section. Pp. 808, with 546 photomicrographs, autoradiographs and camera lucida drawings. Cloth. Price, $8.00. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 18, 1948.

A series of volumes has been prepared as a record of the extraordinary work done during the war by the Manhattan Project and the Atomic Energy Commission. According to the preface of the present volume (which is identified by the number "IV-22 I") the declassified portion of the National Nuclear Energy Series, when completed, is expected to consist of some 60 volumes. Division IV will deal with the Plutonium Project. The present volume has a special interest because it includes so much of the pharmacology of an artificial element, plutonium, unheard of ten years ago. It has six prefaces, all of them interesting because of the light they shed upon the various aspects of the project as a whole. The text deals mainly with the effects of radiations from radioactive isotopes, administered in various ways, but roentgen rays, gamma rays from ra-

dium, and neutron beams from a cyclotron were also used. Slow neutrons were given to mice in boron-lined lead boxes inserted into the tunnels of the Clinton pile.

The 808 pages of the book are devoted to a minute description of the effects of these radiations on all parts of the animal body; the skin, the bones, the various abdominal viscera, the nervous system, and the reproductive organs are taken up individually. A profusion of photomicrographs, autoradiographs, and colored plates gives this book a great documentary value, and it contains much important quantitative information. A concluding chapter summarizes the results, among them the fact that no qualitative differences have been found in the reaction of animals to comparably effective doses of the ionizing radiations studied. Significant differences are found among the isotopes, however; while sodium 24, for instance, remains distributed through the body so uniformly that its effects resemble those of a single large dose of total-body radiation from an external source, barium 140 is an example of others that produce obvious damage only in those radiosensitive organs in which they localize.

In addition to being written in a commendably clear and careful style, the book is thoroughly indexed. It will have permanent value to everyone concerned in the development of radiology.

DICTATORS AND DISCIPLES FROM CAESAR TO STALIN: A PSYCHOANALYTIC INTERPRETATION OF HISTORY. By *Gustav Bychowski*, M. D. Preface by *Carl Binger*, M.D. Cloth. Price, $4.25. Pp. 264. International Universities Press, 227 W. 13th St., New York 11, 1948.

This is a book that should be read by every physician. Dr. Bychowski in a cool and lucid and eloquent book tells the story of Julius Caesar, Oliver Cromwell, Robespierre, Hitler and Stalin. The author tells this story of the rise and fall of these dictators, and what forces flung them into the zenith of history determined their orbits, attracted other bodies to them and finally hurtled them like spent meteorites into the crater of their devastation. Since the author is distinguished as a psychiatrist and psychoanalyst it is to be expected that his interpretation of this history will be a psychologic one without any underestimation of the strength of social and economic forces. The author does not foist his interpretations on the reader. He is far too skilled a clinician to do so. Instead he allows history to tell its story only interposing his own constructions when the facts have all but convinced us.

HOW TO CONQUER YOUR HANDICAPS. By *Marie Beynon Ray*. Fabrikoid. Pp. 336. Price, $3.00. Bobbs-Merrill Company, 724-730 North Meridian St., Indianapolis 7, 1948.

This book is a presentation of the "third phase of medical care," or rehabilitation, in simple, nontechnical language which should prove to be of interest to the handicapped, the lay public and the physician. To support her thesis that no one succeeds without a handicap, the author presents many brief biographical sketches and instances of individuals who have had physical impediments and how they attained seemingly impossible goals because of the handicaps involved. The various types of physical disabilities which are dealt with at some length are congenital and acquired defects of the face, breasts, spine and extremities, paraplegia, impairment of vision, audition and speech, and old age. Also she points out the various physicians who have pioneered in developing new technics for rehabilitating the disabled. Appended to the text is a list of organizations which are helping the handicapped person become a useful citizen and where information may be obtained concerning the proper handling and treatment of such individuals.

This book should be of special interest to the physiatrist since it is concerned with some of the more practical aspects of rehabilitation, and many handicapped patients will be familiar with it.

HEMATOLOGY. By *Cyrus C. Sturgis*, Professor of Medicine, Chairman of the Department of Medicine and Director of the Thomas Henry Simpson Memorial Institute for Medical Research of the University of Michigan. Cloth. Pp. 946, with 93 illustrations, 9 color plates. Price, $12.50. Charles C. Thomas, Publisher, 301-327 East Lawrence Avenue, Springfield, Ill., 1948.

This is a new volume on blood diseases written by an authoritative clinician and laboratory worker whose enviable reputation and superb teaching on this important branch of medicine is world renowned. Each topic is preceded by a historical development which appreciably adds to its presentation and should be enjoyed by the beginning student. Each reference is individually foot noted as well as compiled in a separate bibliography, which is alphabetically arranged by authors and adds to the value of this volume as a reference book.

Fault could be found in this edition by a lack of essential illustrations. The descriptions of cell types are good, but without some graphic demonstration of megaloblasts, megakaryocytes, Gaucher cells or Niemann-Pick cells it is doubtful that a neophyte would be able to recognize these under the microscope. Little attention is given to the determination of the corpuscular constants or to their significance; the implication that the mean corpuscular hemoglobin concentration is raised in pernicious anemia is not valid. This is a most comprehensive and up to date work presented in a readable, precise and scholarly manner.

DIAGRAMS AND DIRECTIONS FOR MAKING EQUIPMENT FOR HANDICAPPED CHILDREN — PARTICULARLY FOR CEREBRAL PALSIED. Paper: Pp. 12, illustrated. Price, $1.00. Association for the Aid of Crippled Children, New York, 1948.

The diagrams in this series have been selected to supplant those already in existence. Other equipment diagrams and pictures may be secured.

PHYSICAL MEDICINE ABSTRACTS

Dissociation Between Pain and Temperature in Spinal Cord Lesions. I. C. Sherman, and A. J. Arieff.

J. Nerv. & Ment. Dis. **108**:271 (Oct.) 1948.

Sherman and Arieff point out that in most textbooks of neurology and neuroanatomy it is generally stated that the fibers of the lateral spinothalamic tract convey the sensations of pain and temperature, leaving the impression that both modalities are conveyed in the same tract and that they suffer simultaneously in disease. The diagnosis of hysteria at times had been erroneously attached to a patient who suffers only the loss of pain sensation with preservation of temperature sense and vice versa. These misunderstandings exist in spite of the fact that there are definite contributions in the literature to indicate that these modalities may be lost differentially by lesions in the spinal cord. The authors present 4 cases which represent instances of dissociation of pain and temperature sense in intramedullary and extramedullary spinal cord disease. In the first case, temperature sense was present but diminished in areas of analgesia in two separated dermatome areas as a result of syringomyelia. In the second case, there was loss of temperature sense in an area where pain sense was well preserved in an intramedullary lesion. Because of this one may postulate separate pathways for pain and temperature. The third case showed preservation of temperature with loss of pain in the presence of extramedullary compression. The fourth case shows loss of pain and cold perception with preservation of warmth perception as a result of an intramedullary lesion. The authors conclude that the functional anatomy of the spinothalmic tract is still not completely understood.

Experience with Radioactive Iodine in the Treatment of Hyperthyroidism. George Crile, Jr., E. Perry McCullagh, and Otto Glasser.

Cleveland Clin. Quart. **16**:1 (Jan.) 1949.

I^{131} differs from many radioactive substances in that its half life, or the length of time it takes to expend one-half of its potential radioactivity, is only eight days. At the end of a month most of the radioactivity is gone, and by two or three months practically none remains. Since the radioactivity of I^{131} disappears in a short time there is no danger of later ill effects due to retention of a long-lived radioactive substance in the body.

The initial dose of I^{131} for patients with Graves' disease is one-half to two-thirds of the average dose required to effect a cure. If 4 mc. are given about half of the patients are well after a single treatment and only 10 per cent develop even a transitory hypothyroidism.

During the past year 105 patients with hyperthyroidism have been treated with I^{131}. Radioactive iodine is a simple, effective, and apparently a safe method of treating patients with hyperthyroidism. Neither hospitalization nor supervision of the patient is required and the cost of treatment is less than that of thyroidectomy or prolonged medical treatment. In 90 per cent of the cases of Graves' disease hyperthyroidism is controlled in two to four months by 1 or 2 treatments. Ten per cent of the patients may require a third treatment. Diffuse goiters disappear after treatment and the symptoms of hyperthyroidism are as completely and effectively controlled as by an adequate thyroidectomy. The only complication which has occurred following treatment with I^{131} is hypothyroidism, usually transitory, which occurs in about the same proportion of cases as after thyroidectomy.

Hyperthyroidism associated with nodular goiters is more difficult to control than the hyperthyroidism of Graves' disease, required larger doses of I^{131} and more treatments. Although nodular goiters become smaller after treatment with I^{131} they do not disappear. I^{131} is the preferred treatment for elderly patients with hyperthyroidism, for those who are poor surgical risks, and for those with recurrent hyperthyroidism. I^{131} appears to be an acceptable method of treatment for younger patients with Graves' disease but final evaluation of its safety in young patients will require many years of observation. At the present time we are employing it in selected cases. I^{131} is not recommended in the treatment of hyperthyroidism occurring in young patients with nodular goiters.

Rheumatoid Spondylitis: Its Early Diagnostic Features and Management. Richard Z. Query, Jr.

J. A. M. A. **139**:692 (March 12) 1949.

Rheumatoid arthritis of the spine is a commonly encountered cause of backache, especially that occurring among male patients of the second and third decades of life. The disease is characterized by periods of active symptoms which alternate with periods of partial or complete freedom from discomfort. After a variable number of years (average fifteen to twenty-five) the process becomes permanently inactive. The end result of the disorder is the production of the so-called "poker spine."

In the evolution of the current concept of rheumatoid arthritis of the spine many synonyms are still in use. The varied terminology serves to confuse one not thoroughly familiar with the fact that involvement of the sacroiliac joints and lum-

bosacral, dorsal and cervical levels of the spine represents the usual progression of one and the same disease—rheumatoid spondylitis. Synonyms frequently encountered in the literature are Marie-Strumpell's disease, spondylitis ossificans ligamentosa of Knaggs, von Dachterew's syndrome, ankylosing spondylitis, adolescent or juvenile spondylitis, spondylitis ankylopitics and spondylarthritis. The designation for this disease which is recommended by the American Rheumatism Association is "rheumatoid spondylitis."

The criteria for the diagnosis of rheumatoid spondylitis are presented. An observation relative to the difference in sex incidence among a small group of private patients with this disease is reported. This observation is at variance with that generally reported. There is no known specific cure for rheumatoid spondylitis. However, if treatment is started early in the course of the disease and continued faithfully, much can be done toward preventing and even correcting spinal deformity. The therapeutic regimen should be well rounded and should include: maintenance of a good general state of health, regulation of rest, diligent execution of deep breathing and postural exercises, appropriate physical therapy procedures and roentgen therapy to the segments of the spine that are actively involved clinically.

Surgical Re'ief of Pain in Shoulder and Upper Extremity. A. F. Jonas.

Pennsylvania M. J. **51**:1377 (Sept.) 1948.

The author points out that pain in the shoulder and upper extremity frequently is dismissed as "neuritis" or treated with heat and salicylates with indifferent or poor results. In a large proportion of cases the pain is caused by a lesion amenable to surgical or orthopedic correction. Understanding of the neurologic pathways mediating such pain is essential. Two of the author's patients with cervical ribs had undergone previous cholecystectomy without relief; another with cervical intervertebral disk had led the restricted life of an anguinal cripple. The author discusses pains caused by lesions of the cervical intervertebral disks and by cervical ribs; also the scalenus anticus syndrome, lesions involving the peripheral nerves and those involving the autonomic nervous system, such as Raynaud's disease and Weir Mitchell's causalgia. Surgical procedures are available for relief of these conditions and deserve a wider appreciation.

Diagnosis and Pitfalls in Diagnosis of Poliomyelitis. A. F. Abt.

J. Lancet **68**:383 Oct.) 1948.

Abt distinguishes three broad clinical types of acute anterior poliomyelitis; namely, abortive, nonparalytic and paralytic poliomyelitis. Neither a clinical nor a laboratory diagnosis can be made for the abortive type of poliomyelitis, because in this systemic phase of the disease a single symptom or combination of any symptoms may be the forerunner of any acute infection. There is no involvement of the central nervous system at this stage of the disease, and therefore lumbar puncture will reveal a normal spinal fluid. Nonparalytic poliomyelitis may be diagnosed from history, symptoms and clinical signs and spinal fluid changes even though no paresis or paralysis develops, particularly in those cases which occur during a season of the year in which polioymelitis is known to be prevalent and during epidemic periods. Such cases were common in Illinois during the summer and fall of the 1947 season. This second stage of the disease involves the central nervous system, and in addition to the general symptoms of fever, headache, anorexia, nausea and vomiting there may be stiffness of the neck and of the back. The most indicative signs for diagnosis are the spine sign (ventral flexion) and the head drop. If both these signs are absent, a positive diagnosis probably will not be made. If one or both are present with characteristic spinal fluid changes, a positive diagnosis should be relatively easy. If paralysis occurs, it usually develops on the second or third day of this phase of the disease. Pain, diminution or loss of the deep reflexes and weakness or twitching of muscle groups may be premonitory signs of approaching paralysis. Only a rapid method for virus identification could positively indicate whether many of the cases seen in Illinois this fall were actually due to the poliomyelitis virus or to such other known viruses such as that of St. Louis encephalitis, equine encephalomyelitis, a different strain of poliomyelitis, or a new and unknown virus. Until a rapid method for virus culture is obtained, only a presumptive and not a positive diagnosis of such cases may be made.

An Anatomical Reason for the Various Behavoirs of Para'yzed Vocal Cords. Brien T. King, and Ralph L. Gregg.

Ann. Otol. Rhin. & Laryng. **57**:925 (Dec.) 1948.

The failure of all paralyzed vocal cords to behave in the same manner has caused much confusion. Many studies and investigations have been made in attempts to clarify and explain the vagaries of such behaviors.

The most common type of vocal cord paralysis observed is due to injury to the trunk of the recurrent nerve, causing paralysis of both abductors and adductors to the cord. As a result of atrophy, fibrosis, and contracture aided by the slight adductor effect of the cricothyroid muscles, the paralyzed cord shifts from an intermediate position to a midline position in the majority of instances.

There still exists in my mind some confusion as to the motor distribution and control of the sphincter mechanism of the larynx. Faradic stimulation of the ramus to the interarytenoideus causes complete contraction of the sphincter mechanism of the glottis on both sides. It may be because the interarytenoideus, even though supplied by both recurrent nerves, reacts to stimulation throughout its entire length or to faradic stimulation from either side. Stimulation of the rami to the adductors and abductors causes only unilateral contraction.

In unilateral recurrent trunk nerve paralysis of the human larynx the interarytenoideus is incapable of effecting the sphincter mechanism on the paralyzed side or of adducting the arytenoid cartilage or vocal cord on the same side.

Experiments have not been conducted on animals like the horse which has a double interarytenoideus muscle with a median tendinous raphe connecting the two muscles. Further studies and experiments will be required in order to completely understand the operations of the sphincter mechanism of the larynx.

New Concepts of Regeneration of Peripheral Nerves. Frederick Hiller.

Quart. Bull. Northwestern Univ. Med. School **23**:50 (Spring Quarter) 1949.

Regeneration of peripheral nerves may proceed within the original mesodermal channels, i. e., the endoneural tubes whereby, as a rule, prompt and complete restitution of function is accomplished. This type of regeneration is called "isomorphous neurotization" and is characterized by the fact that each individual axon regenerates within its proper mesodermal sheath. Contact between ganglion cells and their appropriate peripheral end-organs becomes reestablished. Examples of isomorphous neurotization are to be found in those nerve lesions, which, although they interrupt the continuity of the axis-cylinders, do not disturb the structure of the mesodermal nerve stroma.

Regeneration of peripheral nerves may take place within a proliferating mesodermal tissue resulting from interruption, not only of the axis-cylinders, but also of the mesodermal endoneural tubes. This type of regeneration called "heteromorphous neurotization," is characterized by the fact that the nerve fibers which regenerate in the protoplasma of proliferating Schwann cells, follow the lead of fibroblasts and their collagenous fibers. Thereby a new, heteromorphous structural pattern is created, in which the original connection between ganglion cells, axons and their peripheral end-organs frequently is lost. In this process, many regenerating nerve fibers may be led astray and prevented from establishing contact with the nerve segment distal to the injury. In such cases restitution of function is delayed and incomplete. Examples of heteromorphous neurotization are found in severe nerve contusions, nerve sutures and nerve grafts, particularly of the homogenous variety.

Reconstruction of Thumb by Transposition of Adjacent Digit. R. C. Tanzer, and J. W. Littler.

Plastic & Reconstructive Surg. **3**:517 (Sept.) 1948.

According to Tanzer and Littler a satisfactory reconstruction of the thumb should meet three criteria: (1) sufficient forceful flexion and extension to permit grasping, (2) opposability of the tip of the reconstructed thumb to the pulp of at least one digit and (3) tactile sensation at its tip. The authors describe a method for the reconstruction of subtotal or total loss of the thumb, which meets these requirements. They present 7 cases in which this method was used. In most cases the transposition of an adjacent digit to thumb position requires the use of a pedicle flap to close the intervening defect. It is preferable to perform the transposition and the bony fusion in separate stages in order to obtain a more accurate positioning of the reconstructed thumb. Following fusion, further revision in the nature of tendon transfers and grafts or shortening of the tip is frequently necessary. A damaged digit can often be more effectively employed in reconstructing a thumb than in attempting to restore its useful function as a finger.

Refrigeration in Obstetric Crises. F. M. Allen.

West. J. Surg. **56**:513 (Oct.) 1948.

According to Allen obstetric hemorrhage is the principal cause of maternal death. Obstetricians of a former generation are said to have used the abdominal tourniquet as a final means of stopping postpartum hemorrhage. The method seems to have been abandoned and forgotten, doubtless because of the possibility of shock, paraplegia or organic damage. The author points out that these dangers can be reduced in proportion to the reduction of temperature. The unconscious or deeply anesthetized woman should be picked up by the feet and legs and held vertically with head down, to let all possible flood flow toward the head and the intestine fall toward the diaphragm. A tourniquet should be applied quickly around the abdomen just above the pelvic bones, and the patient immediately replaced horizontally on the table. A large very elastic pure rubber tube should be applied in several superimposed turns. The aorta and other arteries should thus be easily occluded. The legs and abdomen up to an inch or two above the tourniquet should be completely surrounded by finely crushed ice. Though every effort should be used to make the time of tourniquet application as short as possible, reasonably efficient refrigeration will provide ample time for both transportation and operation, even up to the six hour duration. After surgical hemostasis, when the tourniquet is removed, the body temperature should be raised rapidly to a little below normal.

Domiciliary Physiotherapy. Francis Bach.

Brit. J. Phys. Med. **12**:6 (Jan.-Feb.) 1949.

Among the disadvantages which are usually stressed by officials and administrators when this subject is discussed are the following:

(1) Loss to the community of skilled personnel. It is said that both time and money are wasted if the physical therapist is not employed in the most profitable manner. (2) Cost both in time and money often is discussed, but it is invariably the time of the doctor and the physical therapist to which reference is made and not that of the patient.

Advantages are:

(1) The prevention of chronic sickness and the treatment of disease in its early stages. (2) Saving of time, the time of the patient as well as that of the physical therapist. (3) Freeing of hospital beds and the continuation of physical treatment for those patients who have been discharged from hospital. (4) The treatment of patients who cannot get to the hospital even if facilities are available.

A Portable Electrical Manometer Suitable for Continuous Indication of Peripheral Venous Pressures. Albert A. Pollock, and Earl H. Wood.

Am. Heart J. **36**:899 (Dec.) 1948.

Because of the awkwardness and difficulty in handling a water manometer in hospital wards, there is need for a simpler means of measuring venous pressure. An instrument devised to fill this need is described herein.

A portable electrical manometer suitable for continuous indication of peripheral venous pressure has been described. Resting venous pressure in the arm in the supine position was determined in ten normal subjects and found to be 11.3 cm. of saline, with a range of 9.9 to 13.2 centimeters.

By the use of a strain gauge the range of which is ±200 mm. of mercury (Model F 6-4 D-2500), this instrument has been used for continuous measurement of pressure during a trial catheterization. Because the instrument can be read in the dark, pressure can be determined as the catheter is being advanced under the fluoroscope, thus greatly facilitating the procedure of determining the exact moment of entry or withdrawal from the right ventricle or pulmonary artery.

Photographic recording of the pressures has been made simultaneously with the visual readings by connecting a recording galvanometer in series with the galvanometer of the instrument. The frequency characteristics of the combined manometer-catheter system precludes the use of the instrument in its present form for accurate studies of ventricular pressure pulse contours.

Activation of Human Nerves by Ischemia. Trousseau's Phenomenon in Tetany. Eric Kugelberg.

Arch. Neurol. & Psychiat. **60**:140 (Aug.) 1948.

Symptoms of excitation induced with ischemia (compression with a pneumatic cuff) were studied on the human arm in cases of latent tetany caused by forced respiration and hypocalcemia.

The Trousseau sign, or the spasm, is due to ischemic activation, first and foremost, of the proximal part of the longest motor nerve fibers. The electromyographic picture of the spasm is described. The double spikes elicited in this manner are found to be due to an iterative response in the same nerve fiber. The clinical importance of observing the tactile paresthesia in connection with the elicitation of the Trousseau phenomenon is stressed.

In the ulnar nerve, ischemia activates the A nerve fibers according to their threshold for an iterative response to a slowly rising or constant current. The motor discharge elicited by ischemic activation is, in certain respects, identical with that evoked by a slowly rising current. The activity usually starts with a unit of small amplitude, followed by units of progressively larger spikes. The units recruited are often the same, and the frequencies of discharge are likewise similar.

The distribution and order of activation of different tactile and motor fibers in the arm in ischemia correspond well with these factors in ischemic paralysis. The longer tactile fibers, the longer motor fibers, the shorter tactile fibers, the extensor motor fibers and the flexor motor fibers are activated and paralyzed, in the order of enumeration.

These facts are briefly discussed in relation to certain clinical symptoms of irritation and paralysis due to cerebral circulatory disturbances indicating that the characteristics of the different fibers at the periphery and retained in the central pathways.

Sunlight and Skin Cancer in Kenya. F. Piers.

Brit. J. Dermat. **60**:313 (Oct.) 1948.

According to Piers the concept that frequent and prolonged exposure to sunlight may lead to the development of cutaneous cancer in man has received considerable support by recent experimental and epidemiologic work. Since 1941 he has seen 51 cutaneous cancers in the white population of Kenya Colony, where cutaneous cancer is second in frequency only to breast cancer. Most of the patients with cancer gave a history of frequent and prolonged exposure to the sunlight of equatorial Africa. The severe types of chronic sunburn described under the names of farmer's skin and chronic solar dermatitis were present in two-thirds of the patients with cancer. The conclusion seems to be justified that sunlight is the paramount factor in the causation of cutaneous carcinoma in Kenya. The farmer, rancher and white hunter are exposed to the equatorial sun by necessity; but the town dweller, following the command of fashion, exposes himself voluntarily with a truly alarming recklessness. The habit of dispensing with the Victorian sun helmet altogether and of participating in outdoor activities and sports without adequate protection is widespread among the younger generation of Kenya.

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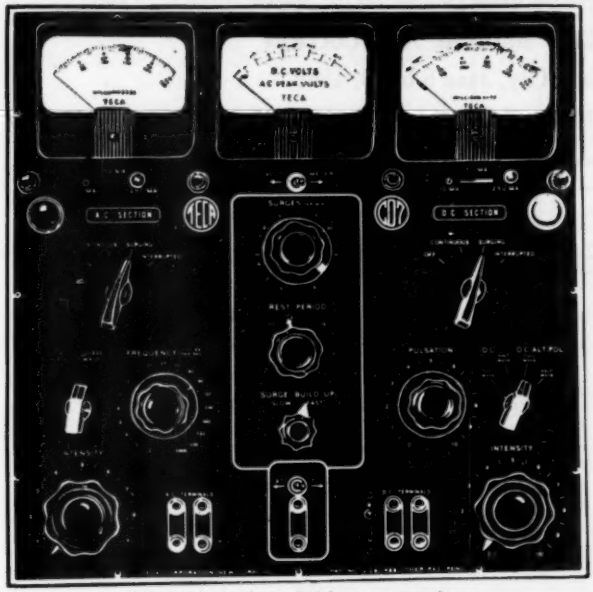

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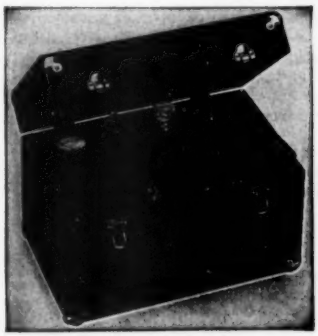

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The principles of remedial exercise (Address of invited foreign guest)
SVEND CLEMMESEN, Copenhagen, Denmark

Coordination exercises and vitamin B_{12} for combined degeneration of the spinal cord in pernicious anemia
FRANK H. KRUSEN; BYRON E. HALL, and HENRY WOLTMAN, Rochester, Minnesota

The rehabilitation of quadriplegics
SAMUEL S. SVERDLIK; GEORGE G. DEAVER, and HOWARD A. RUSK, New York

Physical medicine and rehabilitation in the Veterans Administration
LOUIS B. NEWMAN, Hines, Illinois

PANEL DISCUSSION ON CERTAIN COMMON PROCEDURES IN PHYSICAL MEDICINE AND REHABILITATION
HOWARD A. RUSK, New York, Moderator

What every physician should know about the teaching of crutch walking
GEORGE G. DEAVER, New York

What every physician should know about occupational therapy
SIDNEY LICHT, Boston, Massachusetts

What every physician should know about prescribing physical therapy
GORDON M. MARTIN, Rochester, Minnesota

What every physician should know about the office practice of physical medicine and rehabilitation
GEORGE M. PIERSOL, Philadelphia, Pennsylvania

What every physician should know about the hospital practice of physical medicine and rehabilitation
WILLIAM D. PAUL, Iowa City, Iowa

THURSDAY MORNING, JUNE 9, 9 A. M.

Physical medicine as related to rheumatic diseases (Address of invited foreign guest)
WILLIAM S. C. COPEMAN, London, England

What the Council on Physical Medicine and Rehabilitation has to offer the physician
JOHN S. COULTER; HOWARD A. CARTER, and FREDERICK T. JUNG, Chicago, Illinois

Physical treatment of common lesions of the shoulder (Address of invited foreign guest)
WILLIAM TEGNER, London, England

Physical medicine in peripheral vascular diseases
WILLIAM BIERMAN, New York

PANEL DISCUSSION ON CERTAIN COMMON INDICATIONS FOR PHYSICAL MEDICINE AND REHABILITATION
HOWARD A. RUSK, New York, Moderator

What every physician should know about rehabilitation of the crippled child
ALFRED R. SHANDS, JR., Wilmington, Delaware

What every physician should know about the physical treatment of backache
HANS KRAUS, New York

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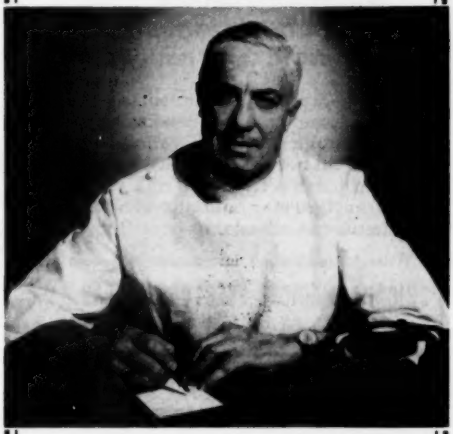

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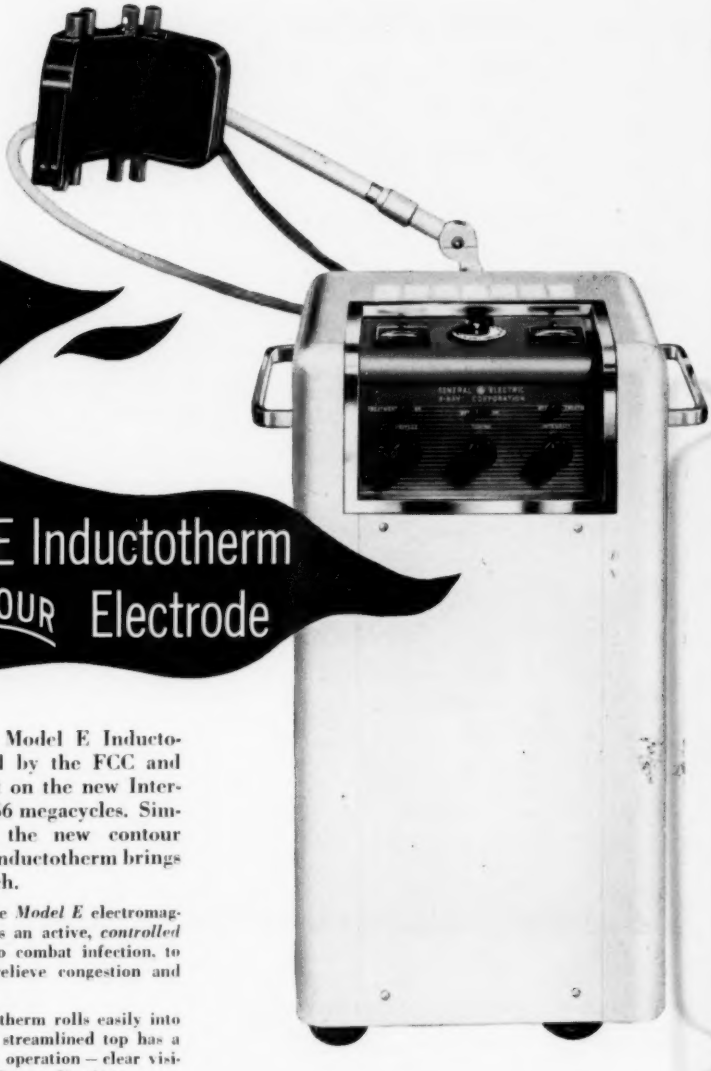

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